CR-194158

NASA
National Aeronautics and
Space Administration

K.F. Jack

IN-3F-CK
12070
P. 221

Technology Utilization Network System [TUNS]

Hardware and Software Recommendations Report

June 12, 1987

TECHNOLOGY UTILIZATION NETWORK SYSTEM (TUNS)

HARDWARE/SOFTWARE RECOMMENDATIONS REPORT

NASA CONTRACT NUMBER: NASW-4164

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SECTION 1.0
GENERAL

The purpose of this report is to make recommendations for hardware and off-the-shelf software to be used within the Technology Utilization Network System (TUNS). With the overall goal of sharing information to improve technology transfer, this document provides the framework and the rationale for the hardware and software recommendations. The methodology for selecting and evaluating products is described. The TUNS technical requirements are defined relative to their impact on the hardware and software selection. A summary of the recommendations is presented, followed by detailed recommendations for specific hardware and software products to be included in TUNS.

1.1 BACKGROUND

TUNS will provide NASA TU the benefits of state-of-the-art office automation technology in their efforts to capture, evaluate, and disseminate technology developed by NASA and by others under contract to NASA. When fully implemented, TUNS hardware will include PCs at each TU-related office, local area networks, one central computer, and a communications network which connects the central computer with all of the PCs. Each location will have a variety of software packages (both off-the-shelf and custom designed) to meet the needs of users at that site. Each PC will be able to operate independently, connected to a local network, and/or as a workstation connected to the central computer facility. Communications capabilities will allow each PC to transmit and receive data, e.g., New Technology Reports (NTRs), management information reports, and budget data.

TUNS will be a fully integrated hardware and software system which will allow for quicker, more uniform, and more efficient information gathering for all aspects of contract administration, new technology reporting, and other technology transfer activities. It will provide TU Offices with software for NTR clause administration, contract correspondence, NTR tracking, awards administration, and general office automation. TUNS will also provide

software for use by the Industrial Applications Centers (IACs) and others involved in technology transfer. This may include software to assist in the preparation and submittal of marketing plans, cost proposal preparation, customer support, and general office automation.

Another feature provided by TUNS will be an automated orientation and training facility. This facility will provide PC-based training in the use of the off-the-shelf and custom developed TUNS software, as well as TU orientations for use in informing contract technical representatives and others about their duties as related to TU.

The system will be developed in two phases. Phase I will concentrate on automating the New Technology administration and management functions, as well as most of the office automation, orientation, and training functions. Phase II will concentrate on automating the IACs, interfacing to the Centers for Commercialization and Development of Space, implementing the centrally maintained databases, and completing the full network capability.

The TUNS design takes into consideration both the overall goals of the NASA Technology Utilization Division, and the particular needs of the end-user. To this end, the TU family has been actively involved in the definition of the functional requirements of the system. The Draft TUNS Functional Requirements Document (FRD) was reviewed and modified by the TU User Working Group to ensure that the users' needs were accurately defined.

In addition, two surveys solicited input from TU Centers, IACs, and support contractors. The TUNS Hardware/Software Survey sought to determine the products currently in use in the TU family, so that existing hardware and software can be utilized when possible. In addition, these sites were also surveyed via electronic mail to determine the capabilities required of word processing, spreadsheet, and end-user database management software.

1.2 METHODOLOGY

The goals of TUNS and the inherent requirements of the system guided the selection of hardware and off-the-shelf software for TUNS. The TUNS FRD and the site requirements survey identified requisite capabilities. Technical requirements, described in this document, further defined the system hardware and software.

The selection process included a literature review, discussions with vendors, and hands-on evaluation of selected products. The functional requirements provided guidance for an exhaustive literature search. The literature search sought to identify currently available products that would meet the TUNS requirements. Published product evaluations and product documentation were examined to determine which software products would be selected for benchmark testing. Final selection of software products for evaluation was based on the following factors: the product's ability to meet functional and technical system requirements, the ability of the product to function effectively and efficiently in the TUNS environment, and the product's track record.

Software engineers performed the software benchmark tests to provide the technical perspective. A management analyst was also included in the evaluation team in order to provide the end-user's perspective. For each software category, the benchmark tests were conducted on the same equipment in order to establish hardware-independent comparisons. Word processing software was tested on an IBM XT with 640 Kb of RAM memory and a 20 Mb hard disk. Spreadsheet and database software were tested on a Compaq 286 with 640 Kb of RAM memory and a 20 Mb hard disk. In addition to the performance benchmarking, factors such as ease of use, ease of learning, cost, and whether or not the product is already installed at the TU sites were used to evaluate the software.

The TUNS Hardware/Software Survey demonstrated that the de facto standard for PC hardware is an IBM-compatible PC. TUNS will use this standard for the workstation in the system design.

Additional hardware, specifically printers, communications devices, and archiving and backup devices, were selected for evaluation based on the literature reviews, functional requirements, compatibility with the TUNS workstation, and discussions with vendors. The hardware evaluation team included software engineers and a systems engineer.

Local area network (LAN) possibilities were examined by a team consisting of a system engineer and an senior software engineer. Functional requirements, data specifications, and manufacturers' specifications were considerations in the evaluation process, as was the ability of the LAN to provide the required hardware and software compatibility and throughput.

1.3 REPORT ORGANIZATION

This report is divided into seven major sections, followed by eleven appendices. Section 1 provides an overview of TUNS. The methodology used to determine the hardware and software recommendations is included, as is a list of terms and abbreviations. Section 2 describes the technical requirements of TUNS, the assumptions on which they are based, and concludes with the conceptual design of the system. Section 3 gives a summary of the hardware and software recommendations. These recommendations and the methodology used are detailed in Sections 4 through 7. The rationale for the selection of specific products is provided and alternate choices, where possible, are recommended. The appendices provide backup information from surveys, evaluations, and the literature review for the products evaluated.

1.4 REFERENCES

A total of six books, 88 articles and reports, and 23 vendor publications were examined and used in the literature review portion of the selection process for the hardware and off-the-shelf software for TUNS. Product evaluations, technical articles, conceptual overviews, and product documentation were included. A complete bibliography is found in Appendix K. Project references are listed below.

U.S. Small Business Administration, Contract NASW-4164 R&D 806/70108 141-10 10-37735 between NASA Headquarters Contracts and Grants Division and Information Systems & Networks Corp., July 1986.

Information Systems & Networks Corp., <u>Technology Utilization Network System (TUNS) Overview & Technical Description</u>, September 1986.

Information Systems & Networks Corp., <u>Technology Utilization Network System (TUNS) Functional Requirements Document</u>, February 1987.

Information Systems & Networks Corp., <u>Technology Utilization Network Systems (TUNS) Hardware/Software Survey</u>, March 1987.

1.5 TERMS AND ABBREVIATIONS

The following terms and abbreviations are used in this report.

ARPA	Advanced Research Projects Agency
ASCII	American Standard Code Information Interchange
bps	Bits per second
CSMA	carrier-sense multiple access
CSMA/CD	carrier-sense multiple access with collision detection
cps	Characters per second
CPU	Central processing unit
DBMS	Database management system
DOS	Disk operating system
dpi	Dots per inch
EGA	Enhanced graphics adapter
FRD	TUNS Functional Requirements Document
ft	Foot/feet
Gbps	Gigabytes per second
GSA	General Services Administration
HDLC	High Level Data Link Control
IAC	Industrial Applications Center
ISN	Information Systems and Networks Corporation
Kb	Kilobytes

Km	Kilometers
LAN	Local area network
Mb	Megabytes
Mbps	Megabytes per second
MHz	MegaHertz
NASA	National Aeronautics and Space Administration
NLQ	Near letter quality
NTR	New Technology Report
PC	Personal computer (or single-user microcomputer)
PSCN	Program Support Communications Network
RAM	Random access memory
SDLC	Synchronous Data Link Control
SNA	Systems Network Architecture
STAC	State Technology Application Center
TU	Technology Utilization
TUNS	Technology Utilization Network System

SECTION 2.0
TUNS TECHNICAL REQUIREMENTS

In addition to the TUNS functional requirements, described in the FRD, the TUNS technical requirements are a significant determinant of the hardware and off-the-shelf software recommended for the system. This section describes those technical requirements, the critical components, and the preliminary assumptions that define them.

2.1 ASSUMPTIONS

Four preliminary assumptions impact the technical requirements for TUNS.

o   The system be will PC-based in order to fully utilize as much existing hardware as possible. It was determined in the TUNS Hardware/Software Survey, submitted in March 1987, that over 85% of the responding sites reported IBM or compatible PC equipment. ISN will, therefore, design TUNS application software and facilities to take maximum advantage of this investment in equipment and personnel expertise.

o   The system will be integrated; that is, all the components must work together. When defining the technical requirements for an integrated system, it is essential that the hardware and software components of the system be selected to maximize the effectiveness of the system as a whole. Certain components are of critical importance and others of lesser importance. Before developing hardware and software recommendations, it is essential to identify the critical components and to evaluate why, and to what degree, they are critical. Then, based on the range of acceptable alternatives available for the critical components, the technical requirements for the system as a whole may be developed.

o   The TUNS functional requirements necessitate several methods of information sharing. The fundamental concept in the TUNS functional requirements consists of sharing information to improve technology transfer. The purpose of TUNS is to facilitate and increase the sharing of information, both within individual organizations and between various organizations (e.g., Centers, Headquarters, IACs, STACs). This is best accomplished when information can be stored in a shared repository accessible to many users. Depending on the data and the user, access may be limited to one user at a time, or many users may be allowed to access the information simultaneously.

o   The most critical components of the system are defined by the information sharing requirements. Defined within the framework of a shared repository, the FRD specifies three different requirements for shared repositories within TUNS: a shared repository for electronic mail; a shared repository for TUNS-wide information (e.g., the TU Team Members directory), referred to as the central site; and a locally shared repository for Center-wide, IAC-wide, or STAC-wide, information (e.g., contract administration information).

Therefore, the system will be PC-based, fully integrated, and capable of providing information shared both locally and centrally. Since the most critical aspect of the system design is its information sharing capability, the two most critical components are the database management system and the communications requirements for transferring information electronically. The following sections describe, in detail, the information sharing components, the technical requirements, and conclude with the TUNS conceptual design.

2.2 INFORMATION SHARING

The demands of the TUNS-specific applications, specifically to provide information sharing capabilities, impose significant technical requirements on the system components. Much of the information, such as NTR status, must be available to different users (e.g., contract monitors, patent counselors) on demand, possibly simultaneously. More precisely, the information should never be inaccessible to a user when it is needed. As a result of these

requirements, the two most critical components in TUNS are the software used for storing and retrieving the data, and the communications facilities necessary to provide for data sharing. Within TUNS, the storage and retrieval mechanisms will be provided by the database management system selected for TUNS application development. The communications facilities will be provided through telecommunications and a local area network.

2.2.1 DATABASE MANAGEMENT SYSTEM (DBMS)

The need for both central and local repositories of information is defined in the FRD. At the central site, the DBMS functional requirements are minimal. The DBMS must support multiple read-only (query) access, and binary file upload capability. At the local level, the FRD requires, for example, that contract information be available to personnel monitoring contracts and to personnel tracking the status of NTRs. In a large TU office, these functions may be performed by different individuals, hence a locally shared repository. The DBMS selected for use at the local level must provide two basic functions.

o   It must support the development of TUNS-specific applications software, including NTR tracking and contract administration. These applications form the core of the TUNS new technology capture function. The DBMS used to develop these applications is, therefore, of critical importance.

o   It must provide tools allowing end-users to develop their own applications. Such tools include a data entry screen generator, a report writer, and a DBMS query capability. The information contained within user-developed applications is, however, entirely dependent on the application, as are all possible needs for sharing the information. TUNS will support the inclusion of user-developed applications.

2.2.2 COMMUNICATIONS

Information can be stored in a shared repository by providing connectivity between the PCs. Currently, the two most common forms of PC connectivity are LANs for local communications, and dial-up telecommunications via a modem to a shared repository (central minicomputer or mainframe computer).

In order to provide all TUNS users with simultaneous access to common information, a local area network (LAN) is needed to connect workstations to the device on which the common information is stored. It is also necessary to provide the LAN software to manage the network. The LAN hardware and software combination must support the DBMS, allowing the DBMS to store and retrieve the common information.

Telecommunications will be used within TUNS to provide access to both the central site and the electronic mail system. The communications hardware and software are the components which support the required telecommunications functionality. Technology has been sufficiently standardized; therefore, most off-the-shelf communications software is capable of supporting most PC software packages.

The FRD specifies that TUNS must provide two kinds of information transfer through telecommunications: ASCII file transfer and binary file transfer. Both of these capabilities are currently available through off-the-shelf products.

An electronic mail system is the additional form of connectivity that will be needed to meet the requirement for communications. The electronic mail capability will be provided by connecting PCs to a commercially-available electronic mail system, using the PC-based telecommunications hardware and software.

2.3 TUNS TECHNICAL REQUIREMENTS

The TUNS technical requirements are those requirements which must be satisfied by the hardware and software components selected for inclusion within TUNS. These technical requirements are mandatory; any component which

does not meet them will not be considered as a potential candidate for incorporation into the system.

As stated above, the most critical component of TUNS is the DBMS. The DBMS selected for TUNS application development must satisfy the following requirements.

o   A networked version must be available, providing for storage of shared DBMS files.

o   The networked version must provide some mechanism for handling record contention (to allow multiple users to access the same file simultaneously).

o   There must be a high level programming language interface.

o   A compiler must be available for the programming language.

o   The programming language must be capable of initiating execution of other non-DBMS software programs (e.g., DOS commands and utilities, a spreadsheet package).

o   The programming language must support structured programming and subroutines.

All of the technical requirements for the DBMS are of significant importance to the functionality of TUNS. Because TUNS is to be an integrated system, the software and hardware components must support the DBMS. In order to achieve this level of system integration, specific technical requirements for the remaining hardware and software components must be met:

o   The LAN network control software must support the application development DBMS.

o   The LAN hardware must support the application development DBMS and the LAN network control software.

o   The LAN hardware/software combination must be capable of supporting from three to thirty users on the LAN simultaneously.

o   The communications hardware and software must be compatible with the workstations and, if shared through the LAN, with the LAN hardware and software.

o   The backup/archiving hardware and software must be capable of supporting the LAN environment, providing for backup of the locally shared TUNS-specific applications information.

o   The workstations must be capable of supporting both the LAN and the application development DBMS.

o   The word processor must be capable of supporting shared printers as well as local printers. It must also provide for transfers between ASCII files and document files.

o   The spreadsheet package must be capable of converting to/from file formats supported by the DBMS for import/export. It must also be capable of transferring information to the word processor.

o   The printers must be supported by the word processor and the spreadsheet packages.

These technical requirements must be met in order to implement Phase I. During Phase II, the LAN hardware/software combination will be required to allow individuals to dial into the LAN in order to input data into TUNS. It will be necessary to analyze the additional hardware and software requirements, both for modems attached to the LAN and for workstations dialing into the LAN, prior to Phase II implementation.

2.4 TUNS CONCEPTUAL DESIGN

TUNS will be a PC-based system, in order to capitalize on existing hardware and software within in the TU community. More specifically, TUNS will utilize IBM PC-compatible hardware, using either the MS-DOS or PC-DOS operating system. The selection of an IBM PC-compatible computer as the TUNS workstation constrains the technical design of the system in that all LAN hardware, LAN software, and off-the-shelf software must be IBM PC-compatible. Workstations which are not IBM PC-compatible may require additional hardware and/or software to interface directly with TUNS.

The physical configuration of TUNS will consist of PCs serving as workstations on a LAN. Attached to the network will be the network file server with a shared hard disk, and shared letter quality and/or laser printers. Each workstation configuration will include a hard disk, a communications modem, and a dot-matrix printer.

The software to be used within TUNS consists of off-the-shelf software packages, TUNS application software, and the LAN system software. The off-the-shelf packages for Phase I include word processing, spreadsheet, communications, database management and utility programs, and are addressed here. Off-the-shelf packages for Phase II will include graphics and project management software. These products will be evaluated prior to Phase II implementation.

The TUNS software will reside on both the hard disk at the individual workstation and the shared hard disk on the LAN. In order to avoid needless system degradation, TUNS will use the workstation for those activities which do not require information from the shared data files. Information created in the local environment may be shared by uploading the file to the server or by transferring the data via floppy disk. Figure 2-1 provides a graphic representation of this conceptual system.

The TUNS menu will provide access to the shared hard disk, and will also be used to select functions which reside on the local workstation. The following functions will be performed at the local workstation:

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o   Word Processing   The word processing software and related site
    specific data files will be stored on the local hard disk. Word
    processing operations will not require access to the network unless
    the output is routed to a shared printer or uploaded to the shared
    hard disk for access by another user. Since this configuration
    enables the user to do word processing locally, the number of
    workstations using word processing will not affect overall system
    performance.

o   Spreadsheet   The spreadsheet software and the related site specific
    data files will be stored on the local hard disk and again will not
    require accessing the network unless the user wishes to extract data
    from the shared data files and download it into the spreadsheet.
    With this configuration, the user will operate at the speed of the
    local PC and may perform extensive calculations on a large
    spreadsheet with no overall system degradation.

o   Orientation/Training   The orientation and training software and data
    files will reside on the shared hard disk and will be downloaded for
    operation from the PC workstation. Using this configuration, the
    on-line training may be self-paced. The user may retain the files
    for use at a later date, restart from the initial database, and
    perform actual database activities in a controlled environment.
    Again, multiple users may be engaged in training without degradation
    of the network.

o   Utilities   The utility software such as desktop accessories, file
    backup, and communications will also reside on the local hard disk.
    Although these packages are selected from the TUNS menu, they perform
    a single user function such as individual calendars, notepads,
    telecommunications access, and file backup. The availability of the
    utilities on the local level allows the individual to define an
    environment suitable to the end-user's method of working. The site's
    office calendar will be maintained on the shared hard disk.

File Server
- Operating System
- LAN Software
- TUNS Application
- TUNS Database Management System
- TUNS Databases And Files

Letter Quality Printer

Laser Printer

Workstation
- Operating System
- TUNS Application
- Spreadsheet
- Word Processing
- Orientation/ Training
- Utilities
- Site Specific Databases And Files

Workstation
- Operating System
- TUNS Application
- Spreadsheet
- Word Processing
- Orientation/ Training
- Utilities
- Site Specific Databases And Files

FIGURE 2-1. TUNS Conceptual Design

o   <u>TUNS Application Software</u> TUNS application software will be resident
on both the local workstation and the shared hard disk. The portion
of TUNS residing on the local workstation will include the software
necessary to provide the applications described above with the
exception of the database tutorial. However, data for the database
training will be resident on the local hard disk. Access to those
portions of TUNS such as New Technology Administration and
Management, Technical Abstracts and Inquiries, Space Benefits
Information, and IAC Administration and Management will be through
the portion of TUNS that resides on the shared hard disk. When the
user initially enters the TUNS system, his authenticity will be
validated through the shared hard disk, and a status check will
ensure the software residing on the local station is the current
version. The user will then be returned to local mode until he
selects an activity which requires accessing the network for
information. The primary purpose of this configuration is to keep
the network traffic at a minimum level while safeguarding both the
data and the user activity.

o   <u>Operating System</u> The workstation operating system will remain at the
local level in order to allow the user the ability to go to the
operating system to perform activities not specifically related to
TUNS.

o   <u>Site-specific Databases</u> The databases designed by each site will
reside on the local workstations; however, the system administrator
can create an access path to place them on the shared hard disk for
community access. Any databases placed on the shared hard disk will
be the responsibility of the user to maintain and will require that
the system administrator create or modify menus in order to be
accessible through TUNS.

The TUNS activity is divided between the local workstation and the shared hard disk. This division will be transparent to the end-user. TUNS will execute the necessary command files to access the network when a function requires data from the shared hard disk. The division of TUNS into local and network functions will ensure the overall responsiveness of the system as the number of users and the amount of data increase over time. The ability to restrict the user when in a training environment will reduce the risk of inadvertent loss of data and will reduce any system degradation resulting from training of novice users. TUNS will include safeguards to ensure that the local stations are operating with the latest version of the software installed on the shared hard disk. To simplify system maintenance, updates to TUNS may be installed on only the shared hard disk by the system administrator and will be automatically downloaded when the user next enters the system. This permits control of the TUNS software even though the software is resident on multiple workstations within the network.

SECTION 3.0
SUMMARY OF RECOMMENDATIONS

As a result of the analysis of the software and hardware for TUNS usage, the following components are recommended as those best suited for inclusion in TUNS. Figure 3-1 shows a typical twelve-user, fully-configured LAN.

LOCAL AREA NETWORKS

o   The Novell Advanced NetWare/286 is the LAN software which offers the versatility necessary to provide an integrated system which will incorporate the variety of existing PC's currently in use at the NASA TU sites. The GSA cost is $1,932 per site.

o   The 3Com Etherlink card is recommended for each workstation and the Etherlink Plus card for the file server. The recommended LAN hardware is thin 50-ohm coaxial cable (RG-58Cu) with bus topology that uses the carrier-sense multiple access method with collision detection (CSMA/CD). The GSA cost of each Etherlink card is $451; the Plus card costs approximately $651. The cost of thin 50-ohm coaxial cable and taps is approximately $3 per foot installed.

o   The file server recommended for the LAN is determined by the estimated number of users on the network and the shared disk space requirements. A small LAN (5 workstations) should use a Compaq DeskPro 286-40 as file server; a medium LAN (12 workstations) should use a Compaq DeskPro 386 with a 70 Mb hard disk; and a large LAN (30 users) should use a Novell T286B with 183 Mb of hard disk as the file server. The T286B includes a tape backup unit and Advanced NetWare/286. The hard disk sizes recommended provide a minimum of 20 Mb of storage for future growth.

   The following are the estimated GSA costs for the file servers, including the network interface cards:

Compaq DeskPro 286-40 as 40 Mb file server	$ 4,738
Compaq DeskPro 386-70 as 70 Mb file server	$ 6,387
Novell T286B with 183 Mb and tape backup	$20,060
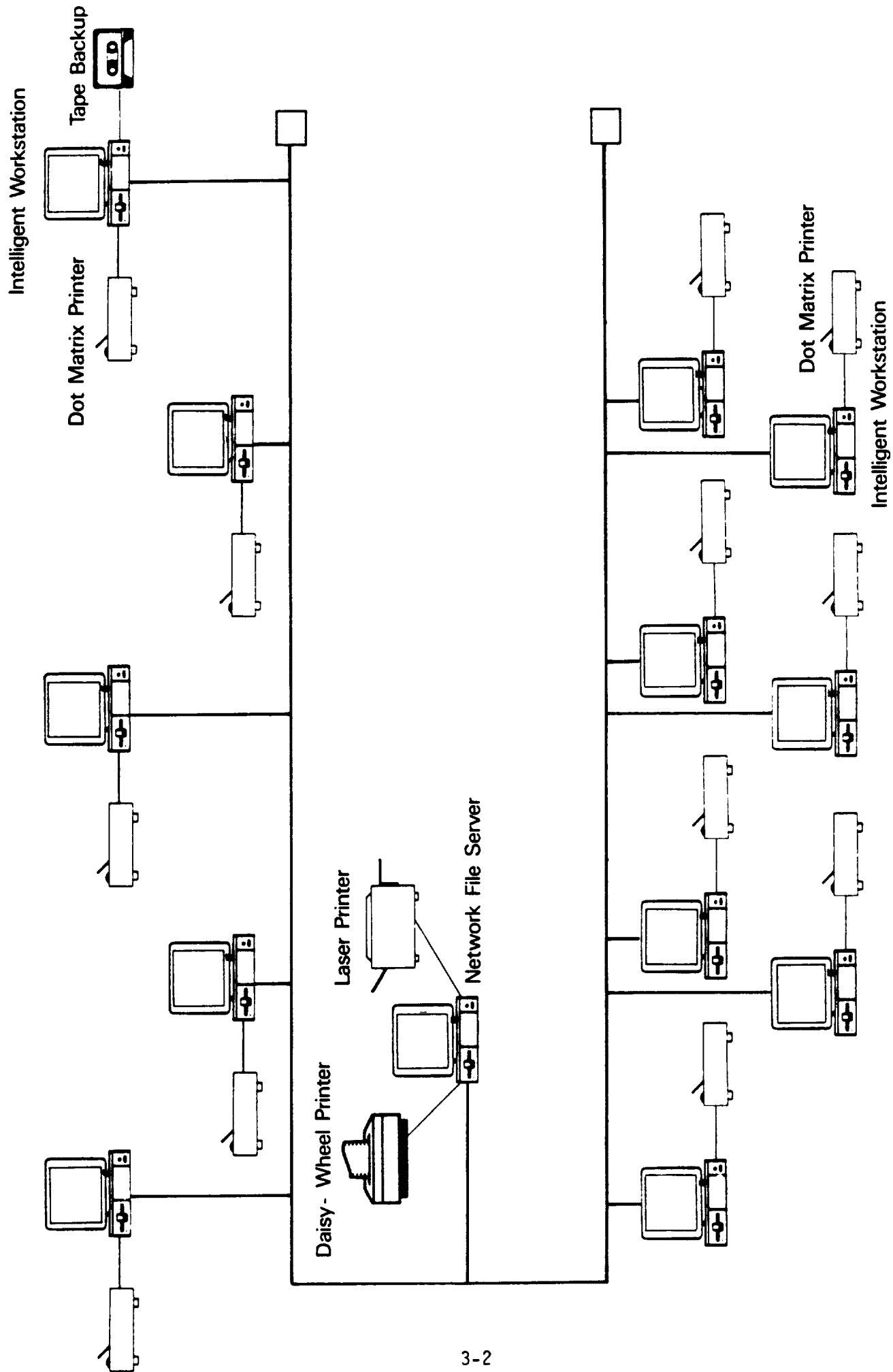
FIGURE 3-1. Typical LAN Configuration

Intelligent Workstation

Tape Backup

Dot Matrix Printer

Laser Printer

Daisy- Wheel Printer

Network File Server

Dot Matrix Printer

Intelligent Workstation

o The tape backup unit recommended for the file server is the Emerald LAN-9100. It offers a 60 Mb tape cartridge with backup software which is fast, reliable, and provides a variety of backup methodologies. The estimated government price is $1,995.

HARDWARE

o The recommended workstation for TUNS is the Compaq DeskPro 286 with a 40 Mb hard disk. While other brands of workstations may be used within TUNS, the DeskPro 286 offers the best combination of speed, dependability, and compatibility. These workstations should be configured with an EGA card, a high resolution color monitor, and expanded memory up to 640K. The estimated GSA cost, including an EGA card and color monitor, is $4,087.

o The recommended dot-matrix printer is the Epson FX-286e with a GSA cost of $527. The recommended letter-quality printer is a Diablo D80IF, having a GSA cost of $1,523. The recommended laser printer is the Hewlett-Packard Laserjet Series II. The estimated Government price is $1,795.

o The internal communications modem which offers the best alternative for TUNS is the Hayes Smartmodem 2400, costing $579 at the GSA price. It is the industry standard and operates at baud rates up to 2400.

SOFTWARE

o Unify Verson 3.2 is the recommended DBMS for both the development and operational phases of TUNS. Unify is a powerful, mature DBMS which operates in a PC, mini, and mainframe environment. It operates under the NetWare 286 network operating system. The government cost for Unify is:

8-user LAN	$2,237/site or $280/user
16-user LAN	$4,337/site or $271/user
32-user LAN	$8,697/site or $262/user

o   Lotus 1-2-3 Version 2.01 is the recommended spreadsheet package, with a GSA cost of $305. It offers a full range of spreadsheet functions at a speed which exceeds that of other packages available on the market.

o   WordPerfect Version 4.2 is the word processor of choice. This product offers a full range of word processing features in a package which is easy to learn, easy to use, and state-of-the-art. The GSA cost is $173.

o   Back-It, which costs $80, is the software selected as the workstation backup software. It is menu-driven offering a range of backup options.

o   HyperAccess is the communications software of choice. The package is moderately priced at $92 (GSA price), yet it offers the communications protocols required for both Phase I and Phase II of TUNS. It is a versatile package suitable for both the experienced and novice communications user.

o   Several utility packages are recommended for TUNS use. These include Sidekick for creating calendars, notepads, and other desktop features; Norton Utilities for use by the system administrator in order to recover user files; Sideways to aid in the printing of large spreadsheets; ScreenSave to protect the life of the monitors; KeyBuffer to allow the user to enter characters from the keyboard at a faster rate than acceptable under DOS; and FilePath to aid in the use of multiple directories and sub-directories. The total estimated cost is less than $300.

The estimated GSA cost of each fully-configured TUNS workstation (excluding workstations also used as file servers), is $6,874. The cost is based on the following components:

Compaq DeskPro 286-40 with EGA card and color monitor	$ 4,087
Epson FX-286e dot matrix printer	527
Hayes Smartmodem 2400	579
3Com Etherlink card	451
Unify	280
Lotus 1-2-3	305
WordPerfect	173
HyperAccess	92
Back-It	80
Miscellaneous utilties	300
Total	$ 6,874

The estimated GSA cost for a five-user LAN, excluding the workstations but including a dedicated file server, one daisy-wheel printer, and a tape backup unit is $10,488, based on the following components:

Compaq DeskPro 286-40 as 40 Mb file server	$ 4,738
Diablo D80IF daisy-wheel printer	1,523
Emerald LAN-9100 tape backup unit	1,995
Advanced NetWare/286	1,932
Installed cable, 100' @$3/ft.	300
Total	$10,488

The estimated maximum GSA cost for a twelve-user LAN, including a dedicated file server, one daisy-wheel printer, one laser printer, and a tape backup unit is $14,382, based on the components listed below. Individual sites, based on a site survey may elect to have only one printer.

Compaq DeskPro 386-70 as 70 Mb file server	$ 6,387
Diablo D80IF daisy-wheel printer	1,523
H-P Laserjet Series II laser printer	1,795
Emerald LAN-9100 tape backup unit	1,995
Advanced NetWare/286	1,932
Installed cable, 250' @$3/ft.	750
Total	$14,382

The estimated GSA cost for a thirty-user LAN, including a dedicated file server with tape backup unit, two daisy-wheel printers, and two laser printers is $28,496, based on the following components:

Novell T286B file server	$20,060
2 Diablo D80IF daisy-wheel printers	3,046
2 H-P Laserjet Series II laser printers	3,590
Installed cable, 600' @$3/ft.	1,800
Total	$28,496

The following table summarizes the total cost of purchasing the recommended hardware and software for a five-user, twelve-user, and thirty-user LAN, assuming that no existing equipment or cabling is used.

	5-USER LAN	12-USER LAN	30-USER LAN
Cost of workstations	$34,370	$82,488	$206,220
Cost of file servers, printers, and tape backup units	10,488	14,382	28,496
Total cost of network	$44,858	$96,870	$234,716
Per workstation cost	$ 8,972	$ 8,072	$ 7,823

TABLE 3-1: ESTIMATED COSTS OF CONFIGURED LANS

SECTION 4.0
HARDWARE RECOMMENDATIONS

In this section, a recommended specification is given for each TUNS hardware device. The reasons for the recommendation are discussed and alternative recommendations are provided when the substitution of the alternative does not compromise the functionality of the TUNS system as a whole.

4.1 WORKSTATIONS

As stated previously, TUNS is a PC-based system. An IBM PC-compatible microcomputer serves as the workstation for the system.

4.1.1 RECOMMENDED WORKSTATION SPECIFICATIONS

The recommended workstation configuration is an IBM AT-compatible PC with the following:

o Intel 80286 CPU and 16-bit bus

o 8 MHz or higher clock speed

o 16-bit hard disk controller

o 640 Kb RAM

o 1 parallel port

o 1 serial port

o 2 empty slots for 16-bit boards (after EGA, network interface and internal modem cards have been installed)

o 1 EGA card (640 x 350 resolution)

o 1 medium/high resolution color monitor (640 x 350 pixels resolution)

o 1 AT-style keyboard

o 1 high-capacity 5 1/4" floppy disk drive

o 1 40 Mb hard disk drive

4.1.2 RATIONALE

The Intel 80286 CPU, the 16-bit bus, the 12 MHz clock speed, and the 16-bit hard disk controller are recommended in order to ensure acceptable workstation performance in the TUNS environment. This hardware impacts both the overall workstation processing capability and the hard disk access time. The bulk of the TUNS office automation capabilities (as distinguished from the TUNS-specific applications) will be implemented using the workstation's hard disk drive; enhanced hard disk performance at the local workstation will increase user productivity and satisfaction.

The database management system recommended for the TUNS-specific applications will require 640 Kb of RAM memory.

The parallel and serial ports are recommended for attaching printers (both parallel and serial), as well as other asynchronous devices (e.g., external communications devices). The availability of both ports will provide significant flexibility in system configuration during Phase II of the TUNS implementation, as will the recommended empty slots.

The empty slots will be available for future expansion (such as adding a local tape backup unit or a special-purpose telecommunications interface card).

An EGA card and color monitor are recommended. The inclusion of project management software and graphics in TUNS Phase II will require the higher resolution and color capabilities provided by this hardware.

The high-capacity 5 1/4" floppy disk drive is recommended both for local backup and for transfer of floppy disk based software and data. The recommended AT-compatible floppy disk drive is capable of storing 1.2 Mb of data on a single high-density floppy disk; it is also capable of reading and writing standard 360 Kb XT-compatible floppy disks. The high capacity option will be used for local backups. The XT-compatible option will be used for software and data transfer, as most PC-compatible software is distributed on standard 360 Kb 5 1/4" floppies.

The hard disk is recommended as the primary storage medium for the local workstation. The conceptual design uses the local workstation hard disk for storage of both software and non-shared data. The following table shows the minimum expected storage required of the hard disk at each workstation during Phase I. These estimates are based on information obtained from the TUNS Project Manager and the TUNS User Working Group.

SOFTWARE/DATA	MB REQUIRED
Operating system software	.7
Utility/miscellaneous software	.5
Communications software	.3
Backup software	.1
Word processing software	1.1
Spreadsheet software	1.5
TUNS application software	.5
Temporary work files	.5
Orientation/training software/data	5.0
Word processing data	5.0
Spreadsheet data	1.5
Site-specific DBMS data	2.0
TOTAL	18.7

TABLE 4-1: WORKSTATION DISK REQUIREMENTS

This does not represent all of the hard disk space required even during Phase I. For example, IACs will require the SortAid software during Phase I, as well as sufficient space for downloading citations resulting from bibliographic searches. During Phase II, additional software will be added at each workstation, including project management and graphics software. The 40 Mb hard disk is recommended in order to ensure sufficient hard disk capacity through Phase II.

4.1.3 ALTERNATIVES

AT-compatible workstations are manufactured by many companies and sold by a wide variety of vendors. It is recommended that the workstations be "name brands," rather than those carrying the label of an unknown manufacturer. The

"name brand" workstations are more likely to be fully IBM AT-compatible. Although many vendors claim to sell "AT clones," ISN has occasionally found very subtle differences in the performance of these "clones," which may result in problems during system integration. Because TUNS will require sophisticated system integration, it is essential that the workstations be truly IBM AT-compatible. A high degree of confidence in the compatibility is required.

When purchasing the workstations, NASA TU sites should evaluate the hardware warranty terms, the installation support, and the availability of vendor-provided maintenance. Because different vendors market the same equipment, the terms and support may vary from vendor to vendor.

ISN surveyed seven vendors of AT-compatible and 386 PCs, asking for information about specific machines (AT&T PC 6300 Plus, IBM AT, Compaq DeskPro 286/386, Zenith 248, Kaypro 286/386). The survey results are detailed in Appendix A. The AT&T PC 6300 Plus was excluded from further consideration because of the 8-bit hard disk controller and the possibility of incompatibility of the 16-bit expansion slots with the IBM AT. The following table summarizes the cost information obtained from the survey.

PC	DISK SIZE	AVERAGE GSA PRICE
Compaq 286-40	40 Mb	$ 3,095
IBM AT	30 Mb	$ 4,400
Kaypro 286	40 Mb	$ 2,901 *
Zenith 248	40 Mb	$ 3,248
Compaq 386-40	40 Mb	$ 4,224
Kaypro 386	20 Mb	$ 5,770 **

* Not on GSA schedule; insufficient empty slots
** Not on GSA schedule

TABLE 4-2: WORKSTATION PRICES

Specifically, ISN recommends that NASA TU sites standardize the Compaq DeskPro 286-40 as the TUNS workstation. The DeskPro 286 will provide the required AT-compatibility at a cost lower than the AT, and it will provide a better disk performance than the IBM AT (see Software Digest Ratings Letter, Special Hardware Report, 1986).

4-4

The cost estimate for the recommended workstations is based on the cost of a Compaq 286-40. Using previously obtained price estimates for an EGA card and medium/high resolution color monitor, the estimated workstation cost is:

Compaq 286-40	$ 3,095
EGA card	425
Color monitor	567
	$ 4,087

Although the recommended workstation is an AT-compatible, it will be possible to use existing IBM XT-compatible machines as TUNS workstations. However, the performance will be degraded due to the CPU chip, the 8-bit bus, the slower clock, and the 8-bit disk controller. While existing XT-compatible or PC-compatible machines can be used, the machines must be upgraded to meet the requirements of 640 Kb of memory and a minimum of 20 Mb of hard disk space.

The use as a workstation of one of the newer 386 machines (based on the Intel 80386 CPU chip) is not currently recommended. The power provided by the 386 system is more than that required of the workstation. If sites procure 386 systems, ISN recommends that the systems contain a minimum of one unused 32-bit slot for future upgrade purposes (specifically, for future 32-bit disk controllers).

4.2 PRINTERS

TUNS will require printers for both reports and correspondence. Both the numbers and the types of printers will vary from site to site, depending on the site size and activity.

4.2.1 RECOMMENDED PRINTER SPECIFICATIONS

Recommended specifications are provided for three types of printers: dot-matrix (suitable for reports and drafts), daisy-wheel (for letter-quality correspondence), and laser (for high-speed letter-quality correspondence) printers.

Recommended dot-matrix printer specifications:

Printer characteristics

o   bidirectional printing

o   graphics capability

o   9-pin minimum dot matrix

o   at least 120 cps print speed in normal mode

o   tractor feed capable of handling 14 7/8 inch paper

o   at least a 2 Kb print buffer within the printer itself

Printer control characteristics

o   Epson compatible or IBM compatible

o   printing features - underline, bold, super/subscripts, expanded, compressed, horizontal and vertical tabs

o   variable page lengths

Recommended daisy-wheel printer specifications:

Printer characteristics

o   bidirectional printing

o   at least 40 cps print speed

o   at least a 2 Kb print buffer within the printer itself

o   capability for both tractor feed and cut-sheet feeder

Printer control characteristics

o   IBM or Diablo compatible

o   printing features - underline, bold, super/subscripts, expanded, compressed, horizontal and vertical tabs

o   variable page lengths

Recommended laser printer specifications:

Printer characteristics

o   up to 8 forms per page

o   at least 8 pages per minute

o   print resolution 300x300 dots per inch

o   graphics capability

o   at least a 2 Kb print buffer within the printer itself

Printer control characteristics

o   printing features - underline, bold, super/subscripts, expanded, compressed, horizontal and vertical tabs

4.2.2   RATIONALE

In determining the standards for TUNS-supported printers, several factors must be taken into consideration:

o   What will the printer be used for?
o   Does the printer have the required capabilities?
o   Is the printer supported by the software?
o   Is the printer cost-beneficial?

The dot-matrix printers will be used for drafts of letters and documents, graphics, spreadsheet printing, and reports from the TUNS-specific applications software. The specific printing features are recommended to support printing of drafts of documents. The graphics capability and 9-pin dot matrix are recommended for dot-matrix graphics. The wide carriage width, handling 14 7/8" paper, is recommended for printing large spreadsheets. Bidirectional printing and 120 cps normal mode speed are recommended to minimize the time the user must wait for reports to be printed. The 2 Kb print buffer is recommended in order to reduce the impact of the printer on CPU processing (i.e., to minimize the extent to which the inherent slowness of the printer degrades the CPU performance).

Because the capabilities of a printer are directly related to the ability of the software to send the correct control codes, ISN recommends that NASA standardize on a specified control code set for use with all TUNS dot-matrix printers. Because of the wide-spread implementation of the Epson control codes, ISN recommends that all dot-matrix printers be Epson-compatible.

The daisy-wheel printers will be used primarily for correspondence, and reproduction quality reports and documents, produced by the word processing software. Because daisy-wheel printers are fairly slow, the time required for a document to be printed can be significant. In order to minimize the impact of slow printing, ISN recommends a minimum print speed of 40 cps, bidirectional

printing, and a 2 Kb internal printer buffer. The availability of both tractor feed and cut-sheet feed is recommended to increase the flexibility of the printer. The printing features (e.g., boldface, superscripts) are required in order to produce reproduction quality (camera-ready) documents.

A commonly used control code set for letter quality printers is the Diablo control codes. Because most word processing packages support the Diablo control codes, ISN recommends this as the TUNS standard.

Sites with significant office automation requirements, particularly sites with many users, will benefit from the use of laser printers. These printers provide very high quality text and graphics. In addition, laser printers are much faster than most daisy-wheel printers. Although Hewlett-Packard has been the industry leader in moderately-priced laser printers, within the last year many new laser printers have been released by competing vendors. The basis of the competition is primarily price and control code set compatibility. Many of the competitors provide H-P Laserjet compatibility, as well as some form of IBM or Epson graphics compatibility.

4.2.3 ALTERNATIVES

With the wide range of printers available, ISN recommends that NASA evaluate the following factors in procuring printers: hardware warranties, installation support and training for laser printers, the availability of vendor-provided maintenance, the availability and ease of installing ribbons or cartridges, and compatibility with the TUNS software.

After selecting a variety of printers based on a literature search, ISN compared the cost per speed for each printer. Because of the competition in the PC printer market, it is difficult to determine the price of a particular model. In an attempt to standardize the price and speed comparisons, ISN used both a vendor survey and a printer survey conducted by PC Magazine, published in November, 1986. The results of the ISN analysis are summarized in Appendix B. In estimating the cost per cps, standard commercial prices and rated printer speeds were used.

Two printers, the Brother Twinwriter 5 and the Fortis DH-45, include both dot-matrix and daisy-wheel print mechanisms. The two companies are actually marketing the same printer under different labels. Although this printer was initially viewed as an exciting combination of functionality at a reasonable price, it was excluded from further consideration after the Twinwriter 5 vendor reported extremely poor reliability and great customer dissatisfaction.

Five wide-carriage (15.5 inches or wider) dot-matrix printers were considered. The three representing the best speed for the price are the C. Itoh C-315XP, the Okidata Microline 193 Plus, and the Epson FX-286e. The recommended dot-matrix printer for TUNS is the Epson FX-286e. It is the most cost effective and is the industry standard. Because of Epson's dominance in the dot-matrix printer market, Epson printers are the most widely available, particularly in non-metropolitan areas. In addition, the Epson printer meets the recommended specifications. For estimating dot-matrix printer costs, the Epson FX-286e GSA price of $527 will be used. The following table gives the cost per speed figures used for comparison.

PRINTER	RATED CPS	COMMERCIAL PRICE	PRICE/ CPS
C.Itoh C-315XP	300	$ 819	$2.730
Okidata 193 Plus	200	$ 749	$3.745
Epson FX-286e	220	$ 799	$3.632
Okidata 293	200	$ 899	$4.495
Epson LQ-1000	180	$1,095	$6.083

PRINTER	RATED CPS	GOVERNMENT PRICE	PRICE/ CPS
C.Itoh C-315XP	300	$ 690	$2.300
Okidata 193 Plus	200	$ 590	$2.545
Epson FX-286e	220	$ 527	$2.395

TABLE 4-3: DOT-MATRIX PRINTERS

The recommended alternative to the Epson printer is the C.Itoh C-315XP. The more expensive C.Itoh provides higher quality graphics and text than the Epson and Okidata models, according to print samples in PC Magazine's November 11, 1986 issue. Support for the C.Itoh is not as universally available, however. Each TUNS site will need to determine the local availability of, and maintenance for, that site's hardware.

Six daisy-wheel printers were considered. Although the Qume Letter Pro Plus represents the best speed for the price, the carriage width is only twelve inches. The Diablo D80IF provides not only a good price/speed ratio, but also a 15.25 inch carriage, permitting the printing of wide spreadsheets for subsequent reduction and inclusion in reports and letters. For estimating letter-quality printer costs, the Diablo D80IF government price of $1,523 will be used. The following table gives the cost per speed figures used for comparison.

PRINTER	RATED CPS	COMMERCIAL PRICE	PRICE/ CPS
Qume Letter Pro Plus	45	$ 899	$19.978
Diablo D80IF	80	$1,650	$20.625
Diablo 635	55	$1,149	$20.891
Brother HR-35	33	$ 780	$23.636
NEC 3515	32	$ 865	$27.031
Olympia ESW 1000	14	$ 549	$39.214

TABLE 4-4: DAISY-WHEEL PRINTERS

Five laser printers were considered, two of which were Hewlett-Packard printers. Of the five, ISN recommends the Hewlett-Packard Laserjet Series II. The two printers with the lowest cost per rated print speed are the QMS Kiss and the H-P Laserjet Series II, as shown in the following table. The government price quoted for both printers is $1,795. The cost of supplies per page for the H-P and the QMS Kiss is approximately equal. Two factors resulted in the recommendation of the H-P. First, the H-P has a bin size capacity of 200 sheets of paper. Many other printers have capacities of 50-80 sheets. Second, the H-P is commonly available, and support for this printer is widespread. For estimating laser printer costs, the government price of $1,795 will be used.

PRINTER	RATED PGS PER MIN	COMMERCIAL PRICE	PRICE/ PPM	SUPPLIES/ PAGE
QMS Kiss	8	$1,995	$249.38	$ .033
Laserjet II	8	$2,495	$311.88	$ .030
Laserline 6	6	$1,995	$332.50	$ .039
Blaser	8	$2,795	$349.38	
Laserjet 500+	8	$4,995	$624.38	

TABLE 4-5: LASER PRINTERS

4.3 COMMUNICATIONS DEVICES

4.3.1 RECOMMENDED COMMUNICATIONS DEVICE SPECIFICATIONS

To provide dial-up asynchronous communications capabilities needed for electronic mail and for accessing the central site, the following specifications are recommended for the communications hardware in each workstation:

o   internal modem on a card

o   Hayes-compatible control codes

o   300, 1200 and 2400 baud rates

o   half-duplex and full-duplex

o   asynchronous and synchronous transmission

o   automatic speed recognition

o   pulse and tone dialing

o   volume-controlled speaker

o   jacks for both data and voice calls

o   auto-dial and auto-answer

4.3.2 RATIONALE

The asynchronous communications capabilities of an AT-compatible PC are more dependent on the communications software than on the hardware. Hayes compatibility is a recognized industry standard, supported by virtually every asynchronous communications package.

ISN recommends a 300/1200/2400 baud (selectable) internal modem in each workstation to handle access to electronic mail and eventually to access the central site, when implemented. For ease of use, ISN recommends an internal modem with automatic line speed recognition, the ability to handle both pulse and tone dialing, automatic dialing, and a speaker to enable users to readily determine any dialing or connection problems. In addition, the jacks for both data and voice will ensure that the telephone wires do not have to be plugged and unplugged frequently. The auto-answer capability will prove beneficial for system integration during Phase II, when TUNS-specific applications information will be transferred between the sites and the central facility.

4.3.3 ALTERNATIVES

ISN reviewed seven modems to determine the capabilities and features. The results of the survey are presented in Appendix C. All of the modems support 300, 1200, and 2400 baud rates, both asynchronous and synchronous transmission, and both half-duplex and full-duplex modes. All are Hayes compatible. The results are summarized in the following table.

MODEM	GSA COST
Anderson Jacobsen AJ Connection II	$520
Hayes Smartmodem 2400	$579
Incomm Turbo 2400	$315
Link Computer SM-24PC	$230*
Microcom AX/2400	$595
Multi-Tech MultiModem 224PC	$426
Paradyne FDX 2400	$396

* Not on GSA schedule; price reflects government discount

TABLE 4-6: MODEMS

ISN recommends the Hayes Smartmodem 2400 for inclusion in TUNS. Of the modems surveyed, the lowest cost modem was the Incomm Turbo 2400. However, further investigation indicates that local user support for this product could be unsatisfactory. Given the low recognition factor in the industry of most Hayes-compatible modems, ISN recommends the Hayes as the best choice. The

individual sites, depending on the support available in their area, may elect to choose one of the compatibles. The GSA cost of $579 will be used for the estimated modem cost.

ISN does not recommend installation of 9600 baud modems at this point. The lack of standard protocols, error-correction methods and data compression techniques for 9600 baud communications means that two modems from different vendors will rarely communicate with each other at 9600 baud. Until standards are well-established and the host computers support the standards, ISN does not recommend purchasing 9600 baud modems.

4.4 ARCHIVING AND BACKUP DEVICES

The term archiving, as used in this report, is defined as the transfer of a logically-related set of information to a medium and/or device for long-term storage. For example, when a contract is closed out, all the contract information will be removed from the active data files as immediate access is no longer required. The information will not be deleted; instead, it will be saved as archived data. When this process is performed, it will be necessary to archive not only the contract data itself, but also other related data such as the correspondence history and NTRs reported under that contract. This means that several different kinds of data need to be written to the archive medium or device, based solely on the data being related in some way to that contract. This also means that the relationships of the individual records must be preserved in order to allow the restoration of the data should questions about the contract require it. Archiving is generally performed using custom application software because of the need to preserve such relationships.

The term backup, as used here, is the process of making a copy of complete files or sets of files in order to protect the data from loss or damage. In the event of disk failure, destruction of files, or inability to access files, information from the backup copies can be restored to the disk. The loss of data is limited to the transactions which were entered into the file after the backup copy was created. Routine backups are normally used for protection against computer system failure or user error. Periodic backups, typically corresponding to data for a month, quarter, or year, may be retained for

historical purposes or for recovery in the event of catastrophic failures. Backups may be made by a single file or by backing up an entire device such as a hard disk.

4.4.1 RECOMMENDED ARCHIVING AND BACKUP DEVICE SPECIFICATIONS

ISN recommends that all archiving of TUNS-specific data be accomplished using high-capacity (1.2 Mb) floppy disks. Since each workstation will have at least one high-capacity floppy disk drive, no additional specifications are necessary for archiving hardware. ISN also recommends that workstation backup be accomplished using high-capacity floppy disks.

The following specifications are recommended for tape backup devices used with the file servers:

o   AT compatible
o   capable of being installed on the LAN file server
o   minimum capacity of 60 Mb per tape
o   minimum data transfer rate of 80 Kb per second
o   software must be provided
o   software capabilities must include:
        menu driven
        backup selection by file, by directory (including
            subdirectories), or entire disk
        backup selection by date/time last modified
        restore all files on tape or by directory or file-by-file
        restore based on date/time last modified

4.4.2 RATIONALE

Archiving to floppy disk is recommended for two reasons. First, the expected volume of data to be archived at any one time is small. Second, the custom software for archiving and restoration will execute faster using the random access provided on floppy disks. Use of random access methods will facilitate preserving the relationships between the archived data.

Backup onto floppy disks is recommended for the local workstations for two reasons. First, only selective backup of data is required. Software, training data, and shared databases will be backed up from the file server.

Second, if selective backups are performed regularly (preferably daily), the volume will be small. Only word processing documents, spreadsheets, and site-specific databases, modified by the user since the last backup, will require backing up at the local workstation. The end-users will be responsible for backing up the workstation hard disks.

The recommended backup method for the LAN shared hard disk is to use a tape backup unit. The entire disk will be backed up on a regularly scheduled basis by the system administrator, during hours when the network is not in use.

The recommended tape drive specifications require AT compatibility in order to ensure that the tape unit and software will indeed be able to back up the shared hard disk. The recommended tape capacity is 60 Mb to minimize the need for changing tapes in the middle of the backup. The 80 Kb per second minimum transfer speed is recommended to ensure that tape backups are accomplished within a reasonable time. At 80 Kb per second, the theoretical times for backing up various volumes of data are:

40 Mb of data	8.3 min
60 Mb of data	12.5 min
80 Mb of data	16.7 min
120 Mb of data	25.0 min
160 Mb of data	33.3 min

Actual performance will be slower than the theoretical times, primarily due to the type of backup (entire disk versus file-by-file) and the efficiency of the backup software.

The software used with the tape unit must be provided by the vendor. Currently, there are no standard technical specifications for interfacing tape units with either MS-DOS or the AT-compatible architecture. As a result, there is no generic tape backup software for AT-compatible machines; rather, vendors provide software for their specific hardware interface.

4.4.3 ALTERNATIVES

ISN reviewed nine different tape systems to determine the most suitable backup devices. The detailed results are presented in Appendix D. The results are summarized in the following table. Costs are included only for those tape units which are AT-compatible and can be installed under Novell Advanced NetWare/286, the recommended LAN software.

TAPE UNIT	TYPE	NETWARE/286 COMPATIBLE	MAX TFR RATE Kb/SEC	GSA COST
Alloy FT-60	cartridge	No	1.5	
Alloy PC-9 Track	reel	No	58	
Emerald LAN-2200	cartridge	No	90	
Emerald LAN-9100	cartridge	Yes	90	$1,496
Genoa Galaxy	cartridge	Yes	86	$1,025
Sysgen Smart QIC-FILE	cartridge	*	1K	
Tallgrass 4060	cartridge	Yes	94K	$1,356
Tech PC 10-12	reel	No	125 inches/second	
Tecmar QIC-60H	cartridge	**	2.5	

   * Unreliable under Novell Advanced NetWare/286
   ** Tapes must be formatted before each use

TABLE 4-7: TAPE BACKUP UNITS

ISN recommends the Emerald LAN-9100 External Tape Backup Subsystem for NetWare LANs. This system is a 15-track serpentine cartridge tape with a 60 Mb formatted capacity. It is well suited for use in the TUNS environment as the backup system for IBM AT and Compaq Deskpro 286 file servers running Novell Advanced NetWare/286 network software. For TUNS sites using other PCs as file servers, Emerald offers a DOS backup subsystem which will also

function in the Novell environment. The speed of the backup process is 2.5 Mb to 3 Mb per minute when the backup is performed on a file-by-file basis. Therefore, the LAN-9100 can backup a 60 Mb fixed disk in approximately 24 minutes. This system requires a 256 Kb of memory and one expansion slot.

The Archival Storage Protector (ASP) software provided by Emerald for the LAN-9100 Tape Backup Subsystem includes the following features of significance to TUNS:

o   ASP is menu-driven with a Lotus-like interface displaying the real time status of the backup.

o   ASP is capable of using multiple tapes in the backup process and will append data from different backup sessions until total tape capacity is reached.

o   ASP is able to provide on-line backup of the network file server while other users are on the system. Therefore, it is not necessary to shut the system down in order to accomplish system administrator functions.

o   ASP is capable of maintaining system security and directory data by backing up all information associated with a file rather than only the file itself. The backup process includes the ability to capture read-only files, hidden system files, network security files, as well as sharable files.

The Emerald LAN-9100 Tape Backup Subsystem has been tested and approved for use in a Novell-286 network. It provides a reliable, fast, and versatile system for the protection of data.

The alternative tape backup system recommended by ISN is the Genoa Systems Corporation's Genoa Galaxy. The Galaxy system includes software which will perform backups by two methods: file-by-file and image. The image backup method is a backup of the complete disk. In order to use the Galaxy system in a Novell 286 environment, a software package called GENWARE must be purchased. This package is used to copy hidden files from the hard disk, and its use is critical when backing up under the image option in order to maintain the file and directory integrity.

SECTION 5.0
LOCAL AREA NETWORK RECOMMENDATIONS

Because sharing of information is critical to the achievement of the goals of TUNS, the local area network (LAN) is critical to the successful functioning of the system. An overview of LAN technology is provided to describe the available options. Specific LAN hardware and software recommendations are made based on the functional and technical requirements of TUNS.

5.1 LAN OVERVIEW

As discussed in Section 2.1.3, TUNS users within a Center, IAC, or STAC, need to share a significant amount of TUNS-specific information (e.g., contractor information, contract data, NTR tracking information). For those organizations that have a need to share common information, a LAN will be required.

In the PC environment, LANs are used to expand the capabilities of single workstations by sharing resources. The two kinds of hardware devices most often shared are hard disks and printers, although other resources (such as communications equipment) can be shared. Printers are shared in order to decrease the cost of less frequently used devices while still making them available to all users. Hard disks, however, are rarely shared in order to decrease cost. Usually, hard disks are shared to provide access to shared data or shared software.

LANs provide shared resources through a network of permanently connected cabling, controlled by a combination of hardware and software. The function of the LAN hardware and software is to support communications between the PCs and the shared resources. In order to provide a common point of reference for discussing communications, the International Standards Organization has developed a model architecture.

5.1.1 OPEN SYSTEMS INTERCONNECTION MODEL

In 1978, the International Organization for Standardization recommended the use of a seven-layer model for communications architecture. The Open Systems Interconnection (OSI) model can be applied to both networked and non-networked communications environments. The model specifies a hierarchy of independent layers (see Figure 5-1), each of which performs a subset of the communications functions. Each layer provides services to the next higher layer and uses the next lower layer as a source of services.

Specific standards have been published, by the International Organization for Standardization, for the physical and data link layers. Generally accepted standards for the other layers are lacking.

The physical layer consists of the electrical and mechanical aspects of transmitting the data on a physical medium. This layer also connects, maintains, and disconnects physical links. The physical layer includes the hardware: interface devices (if any), modems, and communications lines.

The data link layer controls the transfer of data through the physical link, providing for any necessary synchronization, error control, and flow control.

The network layer establishes, maintains, and terminates logical connections between workstations or end points. In a LAN environment, the network layer is used when a workstation needs to communicate, through the LAN, with a device not on the LAN. The three most common functions provided by the network layer are:

o   a bridge or gateway between two physically distinct LANs, allowing workstations on one LAN to communicate with workstations on another LAN;

o   a link from a LAN to a host computer system, through which all workstations on the LAN communicate with the host; and
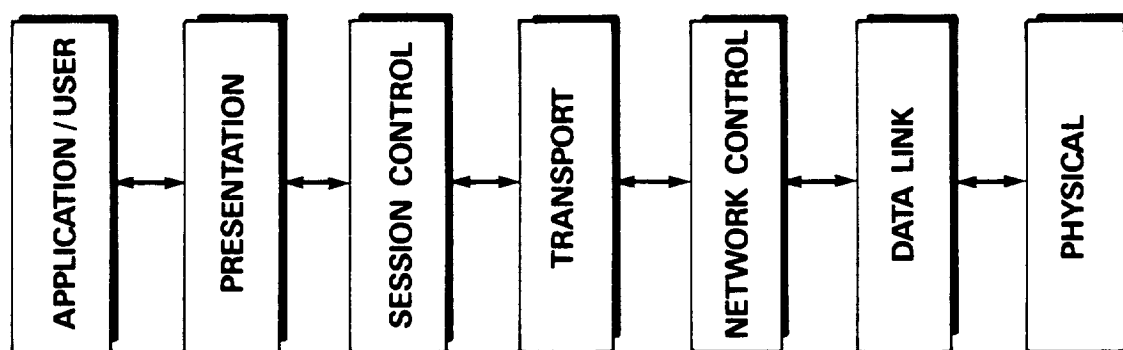
FIGURE 5-1.   Open Systems Interconnection Model Layers

o   a dial-up capability into or out of the LAN (not a specific
     workstation), allowing remote workstations to connect to the LAN
     through telephone lines and to function as permanently connected
     workstations.

The transport layer controls the transfer of data between logical end
points once the path has been established by the network or data link layers.
It provides end-to-end error recovery and flow control, and any necessary
sequencing.

The session layer handles the communications between applications (as
opposed to end points), establishing, maintaining, and terminating
communications between applications.

The purpose of the presentation layer is to provide a standardized
applications interface as well as to perform commonly used data
transformations such as encryption, text compression, reformatting, etc.

The final layer is the application layer, which provides user services
such as resource sharing, file transfers, database management, and network
management (security, status, etc.).

LANs include hardware and software components. The LAN hardware consists
of the physical and data link layers; the LAN software includes the network,
transport, session, presentation, and application layers. The hardware and
software components, however, are not independent of each other and may not be
completely distinct. For example, data link functions may be implemented
through hardware (e.g., on a network interface board), or may be implemented
through software.

5.1.2 THE LAN PHYSICAL LAYER

The physical layer in LAN implementations can be defined by two main
characteristics: the topology and the transmission medium. The topology of
the LAN refers to the way in which the workstations and shared resources are

interconnected. The transmission medium consists of the physical cabling. In theory, topology and transmission media are independent. However, in LAN implementations, these characteristics become interrelated.

5.1.2.1 <u>LAN Topologies</u>

Most LANs are based on one of three basic topologies: star, ring, and bus. More complex topologies are usually combinations of the three basic ones.

In a star topology, illustrated in Figure 5-2, communications control is centralized. Each workstation or shared resource (e.g., printer, hard disk) is connected to a central hub. The hub functions as a data switch. Because the hub must manage concurrent data paths for the various workstations and resources, the hub hardware and software must be fairly complex; however, the workstation communications tasks are quite simple as workstations "talk" only to the hub.

A ring topology is based on a closed loop, shown in Figure 5-3. The data is always transmitted in only one direction. Each workstation on the ring must have a hardware repeater, which receives data on one side of the loop and transmits (repeats) it out the other side. This approach is simpler than the star topology because the network devices, the repeaters, are less complex than the hub of the star. The workstation processing, however, is more complex because each workstation must then perform the functions of packaging the data to be transmitted along the loop and controlling access to the closed loop.

The third basic topology is the bus, which consists of only the cabling media itself: no hub switch, no repeaters. Each device attaches to the linear bus through a hardware interface tap (see Figure 5-4). Any data transmitted on the bus travels the entire length of the bus and can be received by any attached workstation. The bus topology can be viewed as even more simple than the ring topology, in that there are no network devices at all, not even repeaters; consequently, the entire burden of packaging data and of controlling access is placed on the workstations.

FIGURE 5-2. Star Topology

HUB
Controller
CPU
or
Data Switch

Intelligent Workstations

Ring Interface (Repeaters)

FIGURE 5-3. Ring Topology

INTELLIGENT WORKSTATIONS
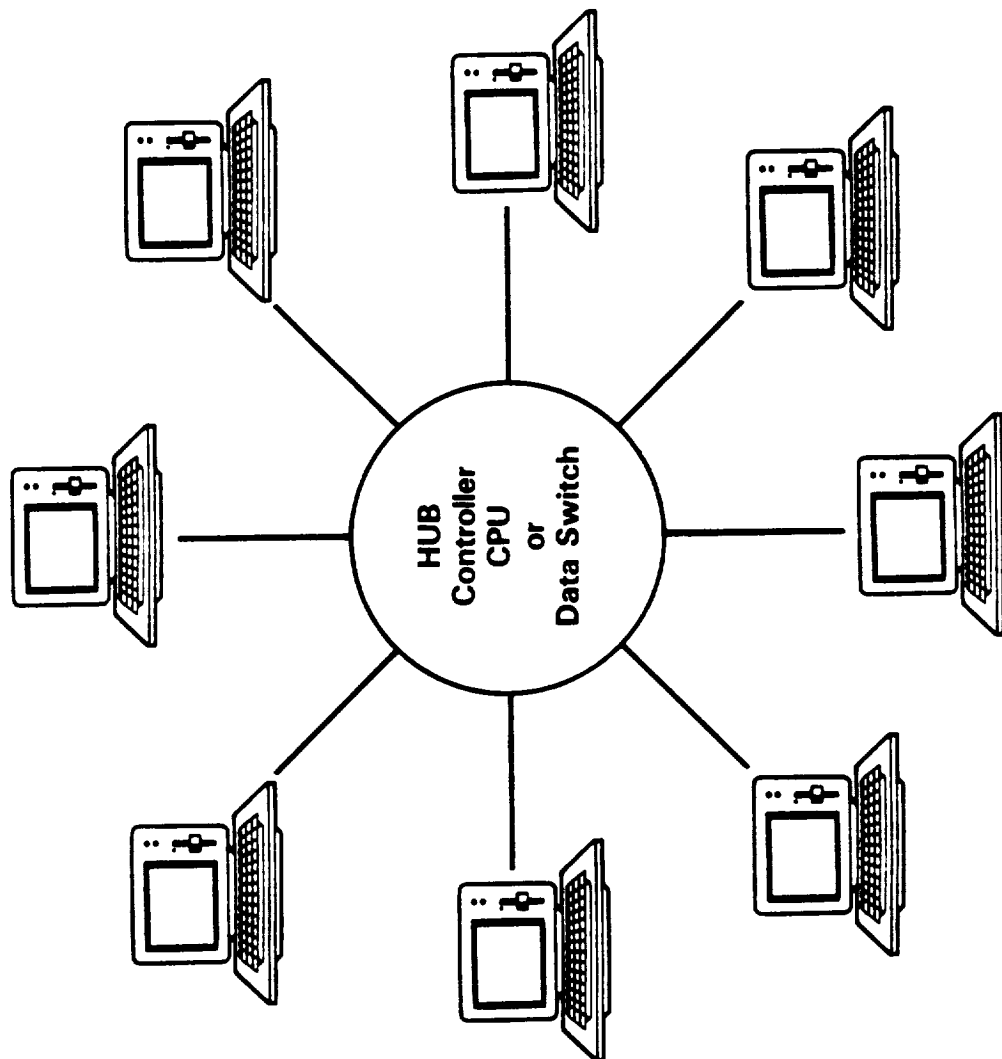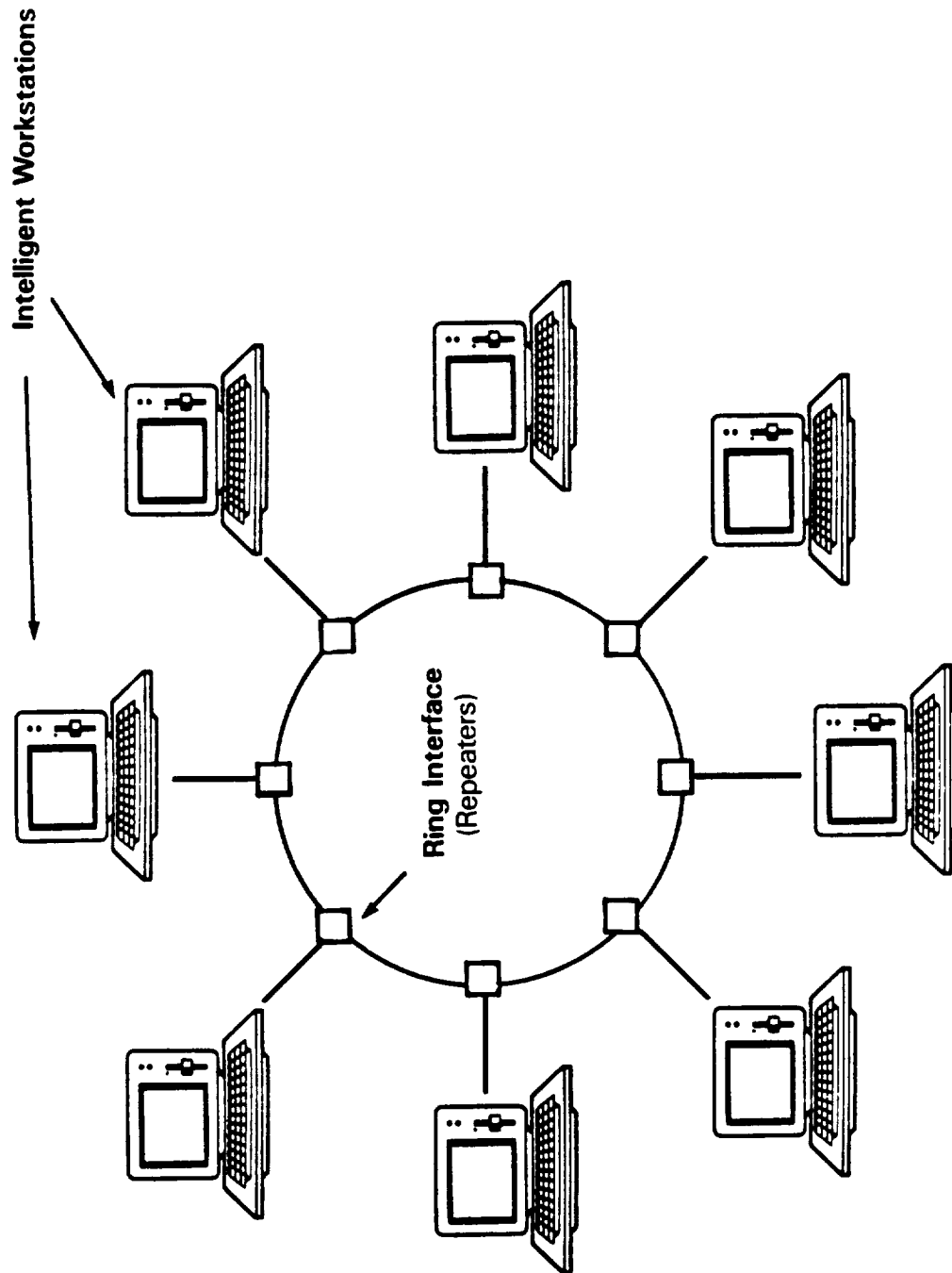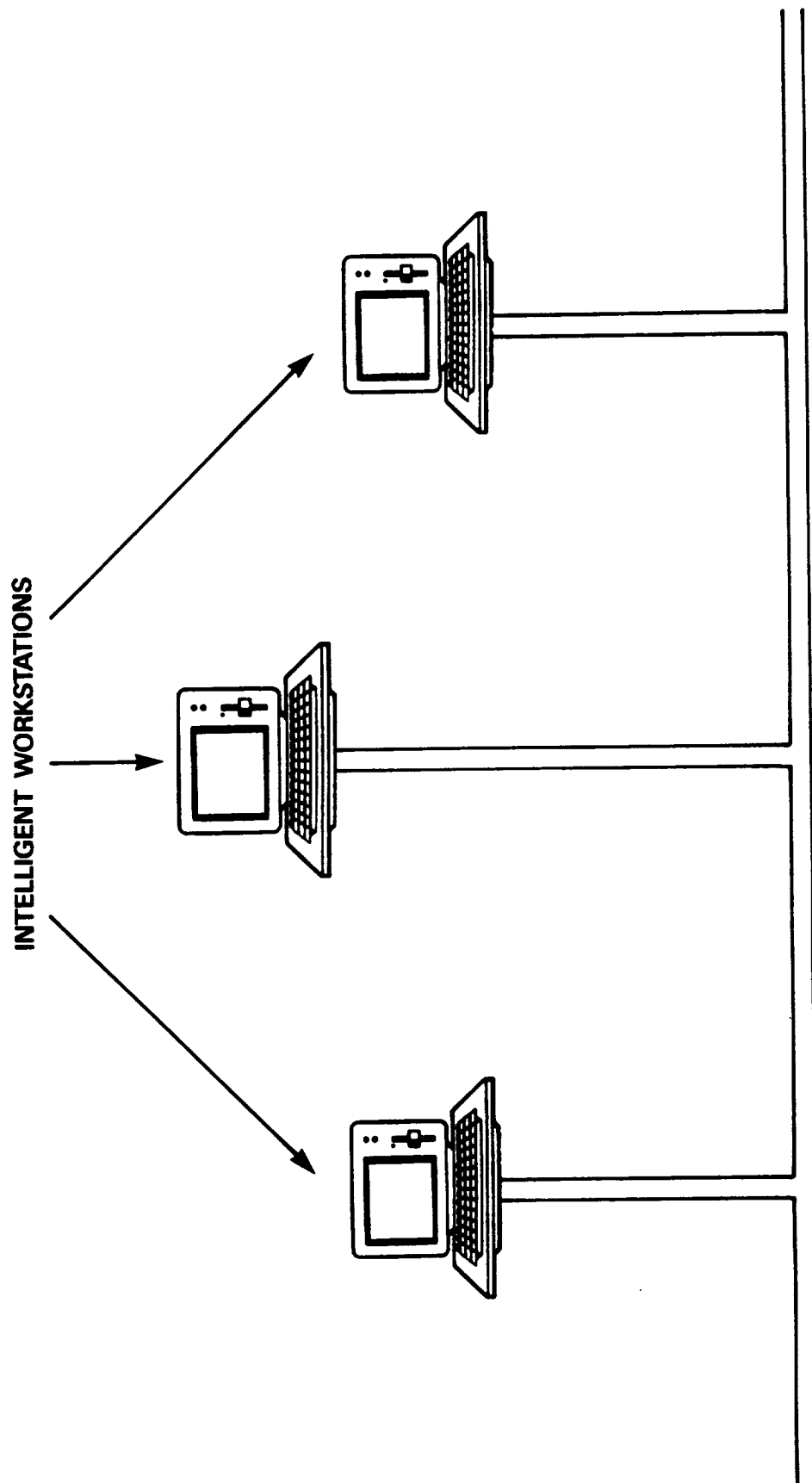
FIGURE 5-4. Bus Topology

Reliability, expandability, and performance are all factors to be considered when selecting a LAN topology. Table 5-1 provides a comparison between the three topologies in vulnerability to failure and in ease of expansion.

TOPOLOGY			
	Star	Ring	Bus

CHALLENGE
Adding new
    workstations
	Must run
	new cable
		Must bring
		network down
			Non-
			    intrusive

Workstation failure	Affects just one	* Brings network down	Affects just one
Network device failure	Hub failure brings network down	* Repeater failure brings network down	No network devices
*Network can be reinitializeo when faulty device is removed from the ring.			

TABLE 5-1:   TOPOLOGIES - VULNERABILITY AND EXPANSION CAPABILITIES

5.1.2.2   LAN Transmission Media

The second characteristic, in addition to network topology, of the physical layer of a LAN implementation is the transmission medium used. All LANs use a cabling medium to connect workstations and other devices to the network. The cabling may be twisted-pair wire, coaxial cable, or fiber optic cable. If the cabling is coaxial or fiber optic, the type of signals passed through the cable may be either digital (baseband) or analog (broadband).

Twisted-pair cabling is the least expensive, in cost of both the cable and installation. It can be reliably used over short distances and at relatively slow data rates. Buildings constructed within the past several years may already have excess twisted-pair wiring installed. Such wiring can be used to implement a LAN; however, it should be shielded twisted-pair cabling, as twisted-pair LANs are highly vulnerable to electrical interference.

Coaxial cable is the most versatile of the transmission media, providing faster data rates over longer distances than twisted-pair wiring. Three types of coaxial cable are commonly used in LANs.

o   Standard 50-ohm cable may be used for baseband LANs. The maximum length of the entire span is 2.5 km; the maximum number of nodes for each segment is 100.

o   Thin 50-ohm cable is a lower-cost alternative for baseband LANs. The maximum length of the entire span is limited to 1 km, with a limit of 30 nodes for each segment.

o   75-ohm standard CATV (cable TV) cable supports either baseband or broadband LANs, although it is rarely used for baseband.

Fiber optic cable supports data transfer at high rates. In addition, this medium is not vulnerable to electrical interference or illegal electro-magnetic taps. However, the medium is currently both expensive and difficult to connect.

Selection of the transmission medium is determined by five interrelated factors:

o   the connectivity (point-to-point linking two transmitting/receiving devices, or multipoint connecting multiple devices);

o   kind of signaling (digital versus analog);

o   required data transmission rates;

o   number of devices on the LAN; and

o   distance between network devices, or total network geographic area.

The following two tables summarize the transmission media characteristics. The values are representative of what is commercially feasible, as opposed to state-of-the-art limits.

	TWISTED-PAIR	COAXIAL	FIBER OPTIC
Total data rate	4 Mbps	500 Mbps	2 Gbps
Repeater spacing	2-6 km	1-10 km	6-8 km

TABLE 5-2:   TRANSMISSION MEDIA SUMMARY - STAR AND RING TOPOLOGIES

	TWISTED-PAIR	THIN 50-OHM COAXIAL	STANDARD 50-OHM COAXIAL	75-OHM COAXIAL
Maximum data rate	1-2 Mbps	10 Mbps	10 Mbps	20-50 Mbps
Type of signalling	baseband	baseband	baseband	broadband
Maximum data rate	1 Mbps	10 Mbps	10 Mbps	20 Mbps
Maximum length	1 km	1 km	2.5 km	10+ km
Maximum number of devices	10's	100's	100's	1000's
Device spacing		.5 m	2.5 m	
Maximum distance between nodes		.2 km	.5 km	

TABLE 5-3:   TRANSMISSION MEDIA SUMMARY - BUS TOPOLOGY

5.1.3 THE LAN DATA LINK LAYER

As discussed in Section 5.1.1, the data link layer controls the transfer of data through the physical layer, providing for any necessary synchronization, error control, and flow control. More specifically, the data link layer controls the access to the physical layer. It also includes logical link control functions to provide services to the higher layers, primarily the network control layer.

By controlling access to the network, traffic on the network may also be controlled. The most common techniques used to control transmission are:

o   token-passing - workstations can transmit only when they receive a "token" giving them the right to transmit;

o   slotted access - each workstation is allocated specific time slots and amounts of data for transmission;

o   polling - workstations are asked, in turn, whether they wish to transmit; and

o   contention - each workstation attempts to transmit data when it wishes; some form of "collision management" is required to determine when two workstations are interfering with each other as they contend for access.

In addition to differing techniques for access control, control of access can be centralized, with one unit in the network determining which devices are accessing which data paths. Alternatively, control can be distributed, with each workstation handling access control. The centralized approach is used in the star topology, with the hub of the star controlling the access. It simplifies the coordination of access control and relieves the workstations of this burden. However, this dependency on the hub means that if the hub fails, the entire network fails. In addition, the centralized unit may bottleneck. With centralized access control, the control unit must decide which workstation is to transmit next. The two most common approaches to controlling transmission with a star topology are polling and slotted access.

Ring and bus topologies, on the other hand, use a distributed approach to controlling access. Each workstation must determine whether it may transmit at any given point in time. One method is to use slotted access, allocating specific time slots to each workstation; however, this is rarely used in a LAN environment. A second method is token-passing, where a workstation wishing to transmit first transmits a token (a few bytes of data) to ask whether it is okay with all the other workstations for it to transmit and, if acceptable, then transmits the data. The third method is contention: workstations compete for time, rather than trying to determine whether it is their turn. Table 5-3 summarizes the relationships between topology and access control methodology.

TOPOLOGY			
	Star	Ring	Bus
TYPE OF CONTROL	centralized	distributed	distributed
CONTROL METHODS	polling slotted access	token-passing slotted access	token-passing contention

TABLE 5-4: ACCESS CONTROL METHODOLOGY

In addition to controlling access to the physical layer, the data link layer must provide services to the higher layers. The logical link control functions serve the higher layers and are not dependent on the physical layer. They provide for error control, including error detection and acknowledgment. In addition, they provide flow control, ensuring that the receiver is not overwhelmed with too much data (e.g., ensuring that printer buffers do not overflow).

5.1.4 THE LAN SOFTWARE LAYERS

Every LAN must have a physical layer and a data link layer, usually contained within the LAN hardware, although some data link layer functions may actually be implemented through software. The other layers, however, are all software capabilities which are, with the possible exception of the network layer, independent of the hardware capabilities. Because the network, transport, session, presentation, and application layers are contained within the LAN software and because the various functions may or may not be implemented within a specific vendor's product, the LAN software is discussed in terms of capabilities provided rather than with reference to the OSI model. A further reason for this format is that standards for the software layers of the OSI model have not been established.

5.2 LAN SOFTWARE

5.2.1 RECOMMENDED LAN SOFTWARE

The recommended LAN software is Advanced NetWare/286 from Novell. The GSA price is $1,932.

5.2.2 RATIONALE

The ISN evaluation team reviewed five different LAN software packages. Of the five, Advanced NetWare excels in its support of a wide variety of LAN hardware. The survey results, detailed in Appendix F, are summarized in the following table.

LAN SOFTWARE	Bundled w/ Hardware	NETBIOS Compatible	Bridge un-like LANs	No. HW Config. Supported	GSA Cost
3Com 3+ Share	N	?	N	2	$1,149
Banyon VINES/286	N	Y	Y	10	1,895
Fox 10-net	Y	Y	N	1	(bundled)
Lee Data LANMASTER	Y	N	Y	6	(bundled)
Novell Advanced NetWare	N	Y	Y	28	1,932

TABLE 5-5: LAN SOFTWARE

Of the LAN software evaluated, FOX 10-net and Lee Data LANMASTER were rejected due to the bundling of hardware and software. Fox 10-net requires the Fox LAN hardware. The Lee Data software will run on a variety of LAN hardware, but requires the Lee Data LANMASTER file server.

The 3Com 3+ Share software was rejected for two reasons. First, the file server uses the MS-DOS directory structure. In general, this will increase the time required to search for files. More importantly, however, is the fact that the file server is not protected by passwords or any other security. Anyone who walks up to the file server can access any of the data on the shared hard disk simply using standard MS-DOS commands. The second reason for rejecting 3+ Share is the lack of NETBIOS compatibility. Although the vendor reports NETBIOS compatibility, a January 1987 article in LAN Magazine indicated that 3+ Share is not fully compatible. This potential lack of NETBIOS compatibility presents a possible system integration problem.

Deciding between VINES/286 and Advanced NetWare/286 for the recommended LAN software was extremely difficult. VINES/286 provides excellent communications interfaces. It also provides better network diagnostics. On the other hand, Advanced NetWare is available on a wider variety of hardware, provides an excellent on-line tutorial, and protects the file server's hard disk from keyboard access.

With Advanced NetWare/286, separately purchased bridging software provides extensive support of inter-LAN communications, both with LANs running Advanced NetWare and with dissimilar LANs supporting the X.25 protocol for the network control layer. In addition, the Novell network will operate through a digital switch; however, a bridging computer and additional software may be required. Advanced NetWare also supports both dedicated and non-dedicated file servers. Because Advanced NetWare/286 takes advantage of the 80286 protected addressing mode, the file server can be used as a workstation with 640 Kb available to the user. Due to the widespread use of Advanced NetWare/286, the network version of most software packages is available under Advanced NetWare.

Advanced NetWare/286 also provides excellent file server performance. The file server operating system is a multi-user operating system which uses its

own basic input/output system (rather than the single-user BIOS which supports MS-DOS). It uses more efficient directory storage and file retrieval techniques than MS-DOS. When the file server is also used as a workstation, MS-DOS runs under the file server operating system.

The combination of performance, hardware flexibility, and ease of use results in the recommendation of Advanced NetWare/286. For currently installed LANs not using Advanced NetWare/286, ISN recommends that the site investigate the possibility of implementing Advanced NetWare with the currently installed LAN hardware.

5.2.3 ALTERNATIVES

ISN strongly recommends that all TU sites implement Advanced NetWare/286. The recommended alternative is the Advanced NetWare upgrade, System Fault Tolerant (SFT) NetWare. SFT NetWare provides all of the Advanced NetWare functionality. It also adds a greater degree of hardware protection to that already present in Advanced NetWare. For sites which have an existing LAN file server and have experienced serious reliability problems, SFT NetWare should be considered as an alternative to Advanced NetWare/286.

At the present stage of TUNS system development, any network operating system which supports the MS-DOS 3.1 File Lock/Unlock functions will support TUNS. The TUNS conceptual design requires only that the DBMS interface with the network file server. Unify, the recommended DBMS, requires only MS-DOS File Lock/Unlock implementation; unlike many LAN DBMS packages, it does not require NETBIOS implementation. However, during the detailed system design process, additional constraints may be imposed upon the LAN software.

5.3 LAN HARDWARE

5.3.1 RECOMMENDED LAN HARDWARE

The recommended LAN hardware is the Etherlink card for each workstation and the Etherlink Plus card for the file servers, using thin 50-ohm coaxial cable. The GSA cost of the IBM-compatible Etherlink Interface card from 3Com Corporation is $451; the Plus card costs approximately $651. These costs are used for estimating network configuration costs.

5.3.2 RATIONALE

The most important consideration in evaluating LAN hardware for a general, site-independent recommendation is flexibility. A bus topology is the most flexible wiring configuration. The star topology has two drawbacks: it is the least able to accommodate network modification; and it usually requires about twice as much cable as a bus topology. Current ring implementations are built as rings of network interface units (which are separate hardware components), with workstations configured as stars off each network interface unit. This again requires approximately twice the cable as a bus topology, as well as requiring the additional hardware of network interface units.

In determining the best transmission medium, fiber optic cable was ruled out due to cost and lack of bus implementations. It is used primarily for point-to-point transmissions, such as star and ring topologies.

For a generic recommendation, coaxial cable is preferable to twisted-pair cabling. Twisted-pair cabling is very susceptible to electrical interference and outside noise, although the vulnerability can be reduced by using shielded twisted-pairs. Twisted-pair cabling cannot be recommended, and should not be used, without a site survey examining the planned cable paths and the proximity to potential sources of interference.

During the process of developing the LAN hardware recommendations, thirteen different products were identified and evaluated. One major difficulty experienced while conducting the survey was distinguishing between LAN hardware and software information provided by the vendors. Table 5-6 shows a summary of the information obtained from the vendors.

The table shows that the 3Com EtherSeries LAN is both the least expensive to implement and supports the highest maximum transmission speed. The Novell Ethernet LAN ranks as the second least expensive, based on the ratio of cost to maximum transmission speed. In fact, Novell is marketing the 3Com Ethernet board under the Novell label.

NETWORK	TOPOLOGY	CABLE MEDIUM	QUOTED PRICE PER WS	MAXIMUM TRANSMISSION SPEED (Mbps)	PRICE PER MAXIMUM SPEED	RUNS NOVELL ADVANCED NETWARE/286
3Com EtherSeries	bus	coaxial	$451	10	$45.10	Yes
AST Resource Sharing	bus	coaxial	$495	5	$99.10	Yes
AST PCNet II	bus	twisted-pair	$495	.8	$618.75	Yes
AT&T StarLan	star	twisted-pair	$477	1	$477.00	Yes
Banyan Vines	*	*	*	1 to 10*		No
Fox 10-Net	bus	twisted-pair	$695	1	$695.00	No
IBM PC-Network	tree	coaxial	$762	2	$381.00	Yes
IBM Token Ring	ring	twisted-pair	$705	4	$176.25	Yes
Lee Data ARCNET	ring	twisted-pair	$595	2.5	$237.60	No
Novell Ethernet	bus	coaxial	$524	10	$52.40	Yes
Orchid PC Net	bus	coaxial	$495	1	$495.00	Yes
Quadram Quadnet VI	star	coaxial	$795	2	$397.50	Yes
Standard Micro ARCNET	ring	coaxial	$584	2.5	$233.60	Yes

* Banyon markets file servers and a network operating system, not a full LAN

TABLE 5-6: LAN HARDWARE

There are several reasons for the low cost of Ethernet LANs. Ethernet is a de facto industry standard, with well-proven technology. It is an open architecture rather than proprietary; as a result, Ethernet LANs are available from a wide variety of vendors, which fosters price competition. A second reason for the low cost is the use of thin 50-ohm coaxial cable instead of standard 50-ohm or 75-ohm coaxial. Because of the greater flexibility of the cable itself, additional transceivers are not required as cable taps. The third reason is the topology, which does not require the additional cost of either network interface units or hubs.

ISN recommends the use of the 3Com Etherlink interface card for each workstation, and the Etherlink Plus card for the file server. The Plus card is recommended over the standard Etherlink card for three reasons: (1) it has its own micro processor so the CPU is free for other transactions; (2) it is 25% - 35% faster than the standard card; and (3) it sends and receives data concurrently. These features, while benefical for the file server, are not required by each workstation.

Both 3Com cards provide additional flexibility not provided by all Ethernet cards: the same card can be installed with either thin or standard 50-ohm coaxial cable. ISN is not recommending the use of standard 50-ohm cable due to the need for additional hardware transceivers as cable taps. However, if the same card is to be purchased by all TUNS sites, the dual

capability may be important. Should the site survey show that the site requires standard 50-ohm coaxial to support the necessary network configuration, the site will still be able to use the TUNS standard interface card.

ISN also recommends that the TUNS Program Office provide each site with consultation and guidance in performing a thorough site survey and in selecting the particular LAN hardware configuration best suited to that site.

5.3.3 ALTERNATIVES

Any LAN hardware using Novell Advanced NetWare/286 as the network operating system is an acceptable alternative to 3Com's Ethernet hardware.

5.4 LAN FILE SERVERS

5.4.1 RECOMMENDED LAN FILE SERVERS

For sites with five or fewer workstations on the LAN, the recommended file server is a dedicated Compaq DeskPro 286 with a 40 Mb hard disk. The estimated cost is $4,738. This is based on the estimated cost of the workstation, $4,087, plus the cost of the network interface card, $651.

For sites with five to twelve workstations, a Compaq DeskPro 386 with a 70 Mb hard disk is recommended. The estimated cost is $6,387.

If a site has more than twelve workstations, the recommended file server is a Novell T286B file server with a 183 Mb hard disk and a 60 Mb tape backup unit. The GSA cost is $20,060. This includes the LAN software, the LAN interface card for the file server, and the tape backup unit.

5.4.2 RATIONALE

Using the TUNS FRD as a starting point, the evaluation team developed the following volume estimates for the TUNS-specific application data residing on the file server hard disk. The details are presented in Appendix G.

Site Size	Required Disk Space	Recommended Disk Space	Recommended File Server	Cost
5 users	24 Mb	40 Mb	Compaq 286	$4,738
12 users	58 Mb	70 Mb	Compaq 386	$6,387
30 users	144 Mb	183 Mb	Novell T286B	$20,060

TABLE 5-7: RECOMMENDED FILE SERVERS

The file server disk space requirements and the requirement to support Novell Advanced NetWare as the operating system are the basis for the recommended servers.

There are advantages to having a file server which has the secondary capability of operating as a fully functional workstation. Although ISN strongly recommends that the file server not be used as a normal workstation, having that capability is often useful. For example, if all the normal workstations are in use, the file server may be used for occasional activities such as writing quick memos or demonstrating the site capabilities to visitors. In addition, expansion can readily be accomplished by upgrading to the next larger file server thus freeing the current server for normal workstation use. However, care must be exercised when using a file server as a workstation. The user must not lock up the workstation because such action in turn locks the network. If the site plans to utilize the server as a workstation, the non-dedicated version of Novell Advanced Netware 286 must be purchased.

Although it is advantageous to have a combined workstation/file server, ISN is recommending a Novell T286B for large LANs. Novell Advanced NetWare is currently available for a Compaq Deskpro 386; however, an external drive would be required to expand it to the 183 Mb capacity required in the large LANS. Because the Novell T286B is a complete unit capable of expansion up to 2 gigabytes, ISN recommends the Novell T286B in order to provide large LANs with the required disk capacity.

5.5 SITE SURVEY REQUIREMENTS

The LAN hardware and software sections have identified the LAN best suited to TUNS use and one which will accommodate the majority of TU sites. NASA Headquarters will specify for each site the additional equipment and software needed to implement TUNS at that site. This information should be used as a guideline to identify what is to be procured at each site. However, ISN must stress the importance of a LAN site survey, performed by either the LAN vendor or the agency telecommunications staff, prior to procurement of the LAN.

The objectives of the LAN site survey will be to define the precise number of workstations, servers, printers, and the telecommunications equipment needed at each site; the precise location of each item of equipment; the estimated growth at the site; the type and amount of cable needed under the office conditions at the site; and the flexibility required of the LAN in order to comply with office modifications projected in the future.

It is conceivable that the site survey may define a requirement for network hardware not anticipated in this study. Before procurement of the recommended LAN, the site should coordinate the requirement with NASA Headquarters to ensure that TUNS will be compatible with the desired LAN.

The site survey should result in a schematic drawing of the LAN showing the cabling, the electrical and telecommunications outlets, and the placement of the hardware. The site survey should also include an installation plan from the vendor who is to provide this service. This plan must describe the site preparation required before the LAN can be installed, the steps required to complete this preparation, the steps required to set up the hardware, the steps necessary to connect the LAN, and the steps necessary to install the LAN software. The plan should also provide estimated completion dates and a list of required equipment for each of the steps detailed above.

Finally, ISN wishes to stress the importance of the site survey process and the importance of the performance of this process being accomplished by professionals who are familiar with the installation of LANs.

SECTION 6.0
SOFTWARE RECOMMENDATIONS

In addition to the hardware and LAN components described in Sections 4 and 5, TUNS will include software. Some of the software will be custom designed for TUNS; however, off-the-shelf products will satisfy the majority of the general office automation requirements. This section provides off-the-shelf software recommendations for six categories: database management systems, spreadsheets, word processors, backup/archiving, communications, and utility/miscellaneous. These products will be implemented in Phase I. Graphics and project management software will be implemented in Phase II.

6.1 DATABASE MANAGEMENT SYSTEM

6.1.1 RECOMMENDED DBMS

The DBMS recommended as the basis for TUNS system development is Unify Version 3.2 from Unify Corporation. The government price for the complete Unify development package is based on the number of users, as follows:

Single-user system	$557		
Four-user system	$1187	or	$297 per user
Eight-user system	$2237	or	$280 per user
Sixteen-user system	$4337	or	$271 per user
Thirty-two user system	$8397	or	$262 per user

6.1.2 RATIONALE

As discussed in Section 2.1.4, the DBMS is one of the most critical components of TUNS. The DBMS must serve two distinct roles: it must support the development of the TUNS system, and it must be suitable for use by the end-user.

In order to support TUNS development, the DBMS must meet the following technical requirements:

o   A networked version must be currently available, providing for storage of shared DBMS files.

o   The networked version must provide some mechanism for handling record contention (to allow multiple users to access the same file simultaneously).

o   There must be a high level programming language interface to support development of the application software.

o   A compiler must be available for the programming language to maximize application response time.

o   The programming language must be capable of initiating execution of other non-DBMS software programs (e.g., DOS commands and utilities, a spreadsheet package).

o   The programming language must support structured programming and subroutines.

Based on a literature search and on the TUNS Hardware/Software Survey, six DBMS packages were selected for detailed evaluation and benchmark testing: dBASE III Plus, Oracle, KnowledgeMan/2, R:Base System V, PC/Focus, and Unify. Additional benchmark tests were performed using dBASE III Plus with Clipper. Clipper, manufactured by Nantucket, Inc., is a software compiler for dBASE III Plus. Clipper compiles dBASE program files into executable machine language files and provides the capability to utilize arrays and menu commands. It can initiate calls to C and Assembly language routines and decrease the execution time of dBASE III applications. After further investigation, Oracle was eliminated as a possibility because a LAN version of the software, although in development for some time, is still not available.

The detailed evaluation examined two separate issues: suitability of the packages for TUNS applications development and suitability as a site-specific end-user DBMS. The benchmark testing consisted of timed tests designed to measure the speed of storing/retrieving records using various keys to access the data. The specific tests were based on the expected demands of the TUNS-specific applications and on the expected kinds of end-user queries. Evaluation and benchmarking details are contained in Appendix G.

The packages were evaluated on six factors for TUNS applications development:

o   programming language support;

o   screen/forms creation and handling;

o   speed (the timed benchmarks);

o   report generation capabilities;

o   quality of reference documentation (distinct from user documentation);

o   minicomputer and/or mainframe availability; and

o   other vendor-provided utilities.

The following table summarizes the evaluation results for suitability in applications development. Of the five packages, Unify was determined by ISN to be the best for applications development.

FACTOR	POINTS POSSIBLE	DBASE III+	KMAN/2	PC/FOCUS	R:BASE SYSTEM V	UNIFY
Language	40	22	29	22	30	38
Screens/forms	20	7	7	10	15	18
Speed	20	6	0	20	19	19
Reports	8	7	5	8	7	8
Documentation	5	5	3	1	4	4
Availability (mini/mainframe)	5	0	0	4	0	4
Utilities	2	1	2	2	2	1
TOTAL	100	48	46	67	77	92

TABLE 6-1: DBMS SUITABLITY FOR APPLICATIONS DEVELOPMENT

In evaluating each of the packages for end-user applications, six factors were considered:

o   number of required features, as identified in the TUNS FRD;

o   ease of use;

o   organization, clarity and completeness of user documentation;

o   availability at TU sites; and

o   cost.

The comparison of the five packages, based on these six factors, is shown in the table below. As indicated in this table, R:Base is the best database for end-user applications, with dBASE III Plus ranking second and Unify third.

FACTOR	POINTS POSSIBLE	DBASE III+	KMAN/2	PC/FOCUS	R:BASE SYSTEM V	UNIFY
Required Features	40	33	28	25	36	34
Ease of Use	25	19	15	17	23	20
Documentation	20	15	10	8	15	13
Ease of Learning	10	9	8	4	9	6
Site Availability	3	2	1	0	1	0
Cost	2	1	1	1	2	1
TOTAL	100	79	63	55	86	74

TABLE 6-2:   DBMS SUITABILITY FOR END-USER APPLICATIONS

The two evaluations, reviewed independently, lead to two different DBMS recommendations: Unify for TUNS applications development, and R:Base System V for end-user development. Although it would be possible to install both databases on each network, the main drawbacks are cost and confusion. The confusion will result from users switching back and forth between the two database packages, having to remember different function key usages and different utility package usages. It is clearly preferable to install just one DBMS. The following table shows the combined evaluation.

EVALUATION	POINTS POSSIBLE	DBASE III+	KMAN/2	PC/FOCUS	R:BASE SYSTEM V	UNIFY
Development	100	48	46	67	77	92
End-User	100	79	63	55	86	74
TOTAL	200	127	109	122	163	166

TABLE 6-3:   DBMS EVALUATION SUMMARY

Unify has several advantages over R:Base System V as a development DBMS. First, Unify is available on many minicomputers and on some mainframes. R:Base is not. The central facility DBMS applications will be developed during Phase II, and the use of Unify would greatly simplify this process. This will decrease the development time, as well as provide a more highly integrated system for the end-user.

Second, Unify provides a built-in language interface with the C language. It is a very efficient, well-implemented interface, since Unify itself is written in C. R:Base System V is written in Fortran and provides a Fortran interface. To use R:Base with C, it is necessary to link together not only the C program, the C runtime library modules, and the R:Base subroutines, but also the Fortran runtime library. This increases the size of the programs significantly, resulting in slower application program loading, execution, and response time.

The major reason that Unify was rated lower than R:Base for end-users is the fact that it is somewhat more difficult to learn. This is partly due to the excellent R:Base help screens. However, it is also due to the complexity and power of the Unify menu system. Users must understand the menu and security approach before modifying menus. Since TUNS will be integrated, very few menu modifications by the users are anticipated.

Once users have overcome the learning barrier, there are several benefits of Unify for end-user applications. For instance when implementing simple applications, such as storing and retrieving a name and address file, end-users familiar with Unify would find it quicker for development. Once the record is defined, a default screen can be created automatically. Using the default screen, users can add, modify, delete, or query records. Such query-by-form results can be displayed on the screen, sent to the printer, or sent to the report writer. None of this requires knowledge of any programming, or knowledge of how to create custom forms.

Another benefit is that Unify provides much better control over access to data in the end-user environment. Through the menu system, Unify controls access to menus and programs based on the user ID or user group. The menu system also controls whether a particular user is allowed to add, modify,

inquire, and/or delete. It is not necessary to define different menus for different users; if a user does not have access to a particular selection, that selection does not appear on that user's screen. So, although there may be only one set of menus, each user may see individual menus.

The third advantage of Unify as a development DBMS is that is allows more complete control of the network and database environment than dBase or R:Base. Specifically, Unify's record and field locking attributes and ease of user password management are better than either dBase or R:Base. Because the entire Unify database is opened as one DOS file, Unify is not restricted by the number of "discrete" databases that may be opened at one time. With Unify it is easier to establish a relational database structure, perform direct standard query language (SQL) queries upon aggregates of data elements, and back up or transmit information from the database.

Fourth, Unify also provides the potential for migrating the software to minicomputers or mainframes. Unlike R:Base, Unify is not tied to the IBM-compatible PC environment. While R:Base started as a single-user PC DBMS which has been expanded to include LAN support, Unify started as a multi-user UNIX-based system which has been down-scaled to the XENIX and the MS-DOS environments.

Fifth, Unify possesses a more powerful search and query language than dBase or R:Base. For example, the SQL supplied by Unify is similar to query languages used by the online search community. In contrast, dBase is similar to a programming language that requires rudimentary knowledge of computer programming to perform complex searches. Another feature of the SQL, supplied by Unify, is its current growth as a widely implemented standard database query language. Therefore, SQL should have a longer lifespan than dBase language.

Unify is the recommended DBMS for TUNS applications development and end-user support. Unify's address is Unify Corporation, 4000 Kruse Way Place, Lake Oswego, OR 97035. The Unify Information Hotline number is (503) 635-7777 for sales office nearest your site.

6.1.3 ALTERNATIVES

The only feasible alternative to Unify is R:Base System V. However, selection of R:Base System V will have a significant impact on the size and complexity of the development process. If R:Base were to be used, a security system and a menu processor system would need to be developed as applications software. These facilities are already available within Unify.

dBASE III Plus, while available at many TU sites, is not recommended for TUNS. Using Clipper significantly increased dBASE III's speed in the benchmark tests (see Appendix G); however, increased speed alone is not a sufficient reason to recommend dBASE III as the DBMS for TUNS. Clipper-complied dBASE code provides programming language support and security over the program code; however, if dBASE Assist is available to the user, the data file contents cannot be protected because Assist can access any dBASE file. Security concerns, and the lack of minicomputer and/or mainframe availability are factors that negatively impact dBASE III's potential for applications development.

6.2 SPREADSHEET

6.2.1 RECOMMENDED SPREADSHEET

The recommended spreadsheet for inclusion in TUNS is Lotus 1-2-3 from Lotus Development Corp. The GSA cost for Version 2.0 is $304.43.

6.2.2 RATIONALE

In determining the evaluation criteria and weighting factors for spreadsheet software, ISN first considered the spreadsheet applications described in the TUNS FRD. With the knowledge of how spreadsheet software might be applied to TU activities, minimum requirements and desirable features were identified. In addition, TU sites were surveyed for their input on required spreadsheet capabilities. The following spreadsheet features were identified as required:

o   menu and command driven;

o   help screens;

o   applications development generator;

o   macro capability;

o   ASCII and other file compatibility;

o   word processing interface (ASCII export feature);

o   graphics;

o   Boolean operators;

o   financial, statistical, and time calculations;

o   manual and automatic recalculation modes;

o   printing macros;

o   printing of ranges and formulas;

o   headers, footers;

o   cut and paste; and

o   stop key.

Based on a literature search and on the TUNS Hardware/Software Survey, three spreadsheets were selected for detailed evaluation and benchmarking: Lotus 1-2-3, Version 2.01; TWIN, Version 1.4; and SuperCalc 4. Lotus 1-2-3 and SuperCalc 4 are both widely-used spreadsheet packages. TWIN is a low-cost Lotus 1-2-3 look-alike.

Each of these packages was evaluated on seven factors:

o   number of required features, as identified in the TUNS FRD;

o   speed (the timed benchmarks);

o   ease of use for the experienced user, partially determined by the number of keystrokes required for a given operation;

o   organization, understandability, and completeness of the documentation;

o   ease of learning;

o   availability at TU sites; and

o   cost of the software.

The evaluation results for required features and speed are detailed in Appendix H. The following table summarizes all the evaluation results:

FACTOR	POINTS POSSIBLE	1-2-3	TWIN	SUPERCALC 4
Required features	40	38	38	38
Speed	20	20	0	7
Ease of use	15	7	8	15
Documentation	10	9	6	9
Ease of learning	10	8	8	10
Site availability	3	3	0	1
Cost	2	0	2	1
TOTAL	100	85	62	81

TABLE 6-4: SPREADSHEET EVALUATION SUMMARY

All of the evaluated packages were equivalent in terms of required features, and approximately equivalent in terms of ease of use, ease of learning, and documentation. However, Lotus 1-2-3 far out-performed the other packages in the speed at which it executed commands. Speed is especially critical to the performance of spreadsheets because their primary function is to execute calculations. In addition to being the fastest, Lotus 1-2-3 is also the most widely available spreadsheet product at the sites that responded to the TUNS Hardware/Software Survey. Eighty-two percent of the sites listing spreadsheet capability named Lotus.

6.2.3 ALTERNATIVE

As an alternative spreadsheet, the software evaluation team recommends SuperCalc 4. This software is not as fast as Lotus 1-2-3, nor as readily available at the TU sites; however, the team found it easier to use. Often, fewer keystrokes were required to execute a given function, and errors were easier to correct. TWIN, although attractively priced, was rejected because of pending legal action against Mosaic (the manufacturer) by Lotus Development Corporation and the fact that the benchmark demonstrated TWIN to be significantly slower.

6.3 WORD PROCESSOR

6.3.1 RECOMMENDED WORD PROCESSOR

The recommended word processor for inclusion in TUNS is WordPerfect from Satellite Software International. The GSA cost for Version 4.2 is $173.00.

6.3.2 RATIONALE

This section describes the evaluation method used and the rationale for recommending WordPerfect.

Word processing capabilities for TUNS were defined based on the anticipated TUNS word processing activities and a survey of TU sites. The features required for word processing software, as described in the TUNS FRD, include:

- o   menu and command driven;
- o   help screens;
- o   save edited files, unlimited document size;
- o   block moves;
- o   insert/overwrite;
- o   cursor movement: character, word, screen, begin, end;
- o   deletes: character, word, screen, sentence, block;
- o   boilerplate;
- o   underlining, boldface;
- o   superscripts and subscripts;
- o   horizontal and vertical scrolling;
- o   search and replace;
- o   multiple columns;
- o   index, table of contents;
- o   headers, footers;
- o   paginate, repaginate;
- o   left/right justified text;
- o   decimal tabs;

o   variable margins;

o   automatic centering;

o   automatic indentation;

o   automatic reformatting;

o   insert printer control codes;

o   insert printer stop codes;

o   printer interrupt;

o   pause for text entry; and

o   scientific notation.

In developing the evaluation criteria and weighting factors for word processing software, particular emphasis was placed on the word processor's ability to satisfy the required features and on its ease of use. Five word processing packages were selected for evaluation, based on the Software Digest ratings for word processor ease of use and versatility: Microsoft Word, Version 3; Samna Word III, Version 2.10; WordStar, Version 3.31; WordPerfect, Version 4.2; and Leading Edge Word Processing, Version 1.3a.

Each package was evaluated on seven factors:

o   number of required features, as identified in the TUNS FRD;

o   ease of use for the experienced user, partially determined by the number of keystrokes required for a given operation;

o   organization, understandability, and completeness of the documentation;

o   ease of learning;

o   speed (the timed benchmarks);

o   availability at TU sites; and

o   cost of the software.

The evaluation results for required features and speed are detailed in Appendix I. The following table summarizes all the evaluation results:

FACTOR	POINTS POSSIBLE	SAMNA	WORD PERFECT	WORD STAR	LEADING EDGE	MICROSOFT WORD
Required features	45	39	44	32	39	42
Ease of use	20	0	18	12	7	19
Documentation	15	10	12	13	10	13
Ease of learning	10	5	8	9	8	7
Speed	5	0	5	4	4	5
Site availability	3	0	2	3	0	1
Cost	2	1	1	1	2	1
TOTAL	100	55	90	74	70	88

TABLE 6-5:   WORD PROCESSING EVALUATION SUMMARY

WordPerfect is recommended as the word processing software for TUNS. WordPerfect is designed for business applications and comes bundled with mail merge, four-function math, proof-reading, and programmable macro capabilities. It has a wide range of formatting features and special text options. Other features include independent on-screen columns as well as automatic creation of index and table of contents. WordPerfect has 98% of the features required by TUNS. It is command driven and makes extensive use of the function keys. The software uses a keyboard template instead of a menu to aid users in performing the desired operation. Software Digest rated WordPerfect's performance and versatility as excellent. Although the evaluation scores for WordPerfect and Microsoft Word show only a two point difference, the evaluation team highly recommends WordPerfect because the evaluation team found it much easier to use WordPerfect's ACSII-to-document transfer features. This capability is a mandatory technical requirement (as specified in Section 2.3), because of the need for information transfer between the various TUNS sites.

6.3.3 ALTERNATIVE

Microsoft Word is recommended as the alternate word processing software for TUNS. Word is menu driven, which makes it easy to learn. In addition, Word contains 91% of the required capabilities. Although the evaluation team rated Word highly, the team found fault with Word in two areas. First, the team felt that the explanations and directions in the manual were not as clear as they should be. More importantly, although industry evaluations indicate that the capability is present, attempts to transfer a Word document file to ASCII format demonstrated that this requisite capability is laborious to use.

WordStar, although widely available at TU sites (both the CP/M and DOS versions), is not recommended for inclusion in TUNS. This recommendation is based on three critical factors. First, WordStar files are not easily transformed into ASCII format, and so are more difficult to exchange with other TU users. In addition, WordStar documents, when viewed on the screen, are significantly different from what is printed on paper. Third, when reformatting text, each paragraph must be reformatted individually, which is time consuming. While many functions are possible with WordStar, the evaluation team felt that WordStar performed these operations more awkwardly than WordPerfect and Word.

Multimate, which emulates Wang's dedicated word processor, is not recommended for inclusion in TUNS. Because preliminary analysis reveals several problems, Multimate was not evaluated in-depth. The ASCII to Multimate conversion is the principal reason for elimination. When a document is converted from ASCII to Multimate, most of the formatting functions are lost; as a result, the user is required to perform extensive edits. In addition, Software Digest's timed benchmark tests indicate that Multimate requires approximately three (3) times as long as WordPerfect to perform standard operations, and almost twice as long as Microsoft Word. Multimate also limits the number of lines in the document, and in a block move. Most other word processors, including WordPerfect and Word are limited only by disk capacity.

6.4 BACKUP AND ARCHIVING

6.4.1 RECOMMENDED BACKUP AND ARCHIVING SOFTWARE

The software package recommended for backup of files on the local hard disk is Back-It by Gazalle Systems in Provo, Utah. This package sells for approximately $80 (commercial price). Volume purchase agreements and/or site licensing agreements are available through negotiation with the supplier.

Archiving software will consist of custom software developed by ISN, due to the requirements for maintaining logical relationships between the data, as discussed in Section 4.4.

6.4.2 RATIONALE

Based on a literature search, five backup packages were selected for evaluation: Back-It; DSBACKUP+; Fastback; Corefast; and Intelligent Backup. The performance evaluation was based on data contained in <u>Software Digest</u> and <u>PC Magazine</u>. The results are summarized in the following table.

FACTOR	POINTS POSSIBLE	BACK-IT	DSBACKUP+	FASTBACK	COREFAST	INTELL BACKUP
Ease of use	25	23	22	16	14	17
Error handling	25	17	17	20	20	20
Speed	20	15	11	20	14	9
Ease of learning	15	11	13	8	9	11
Functionality	10	7	8	6	8	8
Cost	5	5	5	1	2	2
TOTAL	100	78	76	71	67	67

TABLE 6-6:   BACKUP SOFTWARE EVALUATION SUMMARY

Back-It is a menu-driven package that provides the user with the option to backup all files on a disk, backup all files that have been edited or created since the last backup, backup files based on a wildcard criteria, or backup all files in a specified directory. In a benchmark test of backup software performed by <u>Software Digest</u> and published in their March 1987 issue, Back-It was rated the best overall package when evaluated on ease of learning, ease of use, error handling, performance, and versatility. An excellent feature of Back-It is the software's ability to estimate the number of disks required to perform the backup, and to format the disks during the backup process. Formatting the disks during the backup process eliminates a time consuming step which must be performed in the standard DOS backup procedure.

The principal strengths of Back-It are the following:

o   fast backup of revised files;
o   ease of restoring from the backup disk on either selective files or wildcard criteria;
o   fast disk formatting during single directory backup;
o   excellent manual and reference materials;
o   warning of file overwrite during backup;
o   automatic formatting of floppy disks;
o   automatic switching between two destination drives;
o   estimate of the number of floppy disketts required; and
o   records backup statistical data.

Back-It has three principal weaknesses.

o   File version cannot be selected during restoration.
o   Backup to a partially filled disk results in loss of data on the disk.
o   Error identification and recovery instructions could be improved.

6.4.3 ALTERNATIVES

The alternative to Back-It is the software package DSBACKUP+. This package is marketed by Design Software, Inc. from Chicago, Illinois and sells commercially for approximately $80. This package has many of the same features as Back-It. In addition, it can backup to a partially filled disk and will allow a choice of file version during restoration. Its major weaknesses are that it does not warn the user of a file overwrite, does not record backup statistics, and does not display the most recent backup information. In the benchmark performed by the Software Digest, the performance of DSBACKUP+ was significantly less than Back-It.

6.5 COMMUNICATIONS

6.5.1 RECOMMENDED COMMUNICATIONS SOFTWARE

The recommended communications software is HyperAccess from Hilgraene, Inc. This software is available at the GSA cost of $92.

6.5.2 RATIONALE

Based on a literature search, five communications packages were selected for evaluation: HyperAccess, Crosstalk XVI, Omniterm 2, Microsoft Access, and Smartcom II. The performance evaluation was based on data contained in Software Digest and PC Magazine. The results are summarized in the following table.

FACTOR	POINTS POSSIBLE	HYPER-ACCESS	CROSSTALK	OMNITERM	MICROSOFT ACCESS	SMART-COM II
Ease of use	25	19	20	21	22	17
Error handling	25	17	16	15	20	17
Speed	20	16	16	13	4	9
Ease of learning	15	10	10	12	12	9
Functionality	10	7	7	5	7	5
Cost	5	4	2	5	1	4
TOTAL	100	73	71	71	66	61

TABLE 6-7:   COMMUNICATIONS SOFTWARE EVALUATION SUMMARY

The HyperAccess communications software offers the user a full range of communications options at a moderate price. The package is extremely versatile, yet offers a transmission speed only slightly below Crosstalk. The features of HyperAccess which put it beyond the standard list of FRD requirements are:

o   baud rates up to 19.2 Kb bits per second;

o   asynchronous protocols with error checking of CRC XMODEM, Checksum XMODEM, and Kermit;

o   unattended transmission of data at a special time;

o   remote/unattended operations with logging of calls;

o   exiting program without losing the carrier;

o   on-line file handling; and

o   switching from voice to data and vice versa.

The HyperAccess communications package will serve the novice user as easily as the user experienced in transferring data using various protocols. The HyperAccess package offers a tutorial disk that walks the beginner through the basics of communications. However, menu screens are available which can also guide the novice user through the communications setup process without using the tutorial or the reference manual.

For the experienced user, HyperAccess offers a macro/programming capability which includes user defined command files, assigning macros to a log, batch operation from DOS, wait for a condition, and logic commands such as "if-then-else."

The overall features of HyperAccess which make it the recommended software are the unattended operation functions, the availability of three transmission protocols, its versatility of acceptable hardware, and its ease of use for novice users. HyperAccess offers options which will be significant in Phase II development.

6.5.3 ALTERNATIVES

The recommended alternative is Crosstalk XVI. The performance rating of Crosstalk exceeds that of all the packages except HyperAccess; however, Crosstalk is not as easy to learn for the novice user and offers fewer features than HyperAccess. If users have or intend to purchase a Hayes internal modem which includes the Smartcom II software, or if they currently have either Crosstalk XVI or Smartcom II, they should use these packages for communications. If users intend to purchase communications software, the preferred package is HyperAccess.

6.6 UTILITIES/MISCELLANEOUS

6.6.1 RECOMMENDED UTILITIES AND MISCELLANEOUS SOFTWARE

The following utility software is recommended for use within TUNS:

o   Sidekick by Borland International at a cost of $54;
o   Norton Utilities by Norton Software at a cost of $49;

o   Sideways by FUNK, Inc. at $36; and

o   FilePath, ScreenSave, and KeyBuffer from bulletin boards for a total
     of $150.

6.6.2 RATIONALE

The Sidekick software will be used within TUNS to provide the office
calendar and the personal calendar and notepad features.

One copy of Norton Utilities is required for the system administrator's
use in assisting the end-users in the event of deletion or loss of their
personal files. Norton Utilities cannot be used on the file server to perform
these recovery operations.

Sideways is a software package which assists in the printing of large
spreadsheets. A copy of this software should be made available at every
workstation.

The FilePath software aids in the location of data files in a multi-level,
multi-directory system. This software is used in conjunction with the DOS
PATH command.

The ScreenSave utility is used to blank the monitor if no activity is
performed within a specified period of time. This utility reduces the chance
that data will be burned into the screen over a period of time.

The KeyBuffer utility increases the size of the input buffer and permits
type-ahead in excess of that under standard DOS conditions.

The only utility software which is required by TUNS is Sidekick; however,
ISN strongly recommends the procurement of the additional software which will
aid end-users in their use of the PC.

SECTION 7.0
ELECTRONIC MAIL

7.1 ELECTRONIC MAIL REQUIREMENTS

One goal of TUNS is to facilitate better communications between the members of the TU family. Electronic mail will be used as one of the methodologies to accomplish this goal. The electronic mail requirements as identified in the FRD include the following:

o   TUNS electronic mail must allow the user to compose the body of a message using either a local word processor or in the electronic mail system itself. A line editor must be available for use with messages prepared within the electronic mail system. Text data files prepared by the word processor must be capable of being incorporated into the body of the message.

o   Electronic mail must provide the user with the ability to create a permanent file of outgoing messages.

o   The user must be able to file incoming messages by user requirements (e.g., subject, sender, date).

o   The sender must be able to identify a single recipient, multiple recipients, and a "group" mailcode consisting of multiple mail identification codes but addressed as one unit.

o   The electronic mail system must provide the following features: to, from, carbon copies, receipt requested, date, subject, forward, respond, message retrieval and message purge by criteria such as date, sender, subject, number, and unread/unpurged.

o   The electronic mail system must maintain messages in such a manner that all messages are secure and confidential except to those individuals listed as to, from, or carbon copies.

o   The electronic mail system should inform the user at sign-on or at appropriate times during the session if new mail exists for him.

7.2 RECOMMENDED ELECTRONIC MAIL SYSTEM

In January, 1987, ISN prepared a study of electronic mail alternatives and presented it to the NASA TU Division in a memorandum (see Appendix J). The results of this study will be used as a basis for the electronic mail recommendation contained in this document.

The recommended electronic mail for use in TUNS is the NASAMAIL system currently available throughout NASA. The NASAMAIL system is equivalent to the US Sprint TELEMAIL system described in the study. The NASAMAIL operates on the NASA PSCN communications network and is available at all the TU offices and IACs in the NASA community.

Table 7-1 presents a comparison chart of the electronic mail features provided by the six major commercial electronic mail vendors and by Lawrence Livermore National Laboratories, the current supplier of TU electronic mail. As shown by the chart, TELEMAIL provides all the features required by TUNS.

Table 7-2 presents a cost comparison matrix of the electronic mail vendors based on a transmission rate of 7,200 characters per hour. As indicated by the matrix, TELEMAIL has the lowest cost of the commercial vendors. NASAMAIL is the standard electronic mail system within NASA, and the cost of NASAMAIL is an overhead budget item.

An additional factor in the selection of NASAMAIL as the electronic mail supplier is its use of the PSCN network. The PSCN network provides an existing communications network which not only permits access to the entire TU family, but can be used to access other networks such as Defense Data Network and the ARPA network.

	MCI MAIL	TELEMAIL	ONTYME	DIALCOM	EASYLINK	GRAPHNET	LLNL
SERVICE CATEGORIES							
BASIC	X	X		X			
ADVANCED	X	X	X	X	X	X	X
ADDRESSEE							
ELECTRONIC ADDRESS	X	X	X	X	X	X	X
HARDCOPY ADDRESS	X	X			X	X	
TELEX TERMINAL	X	X		X	X	X	
HELP CATEGORIES							
ON LINE	X	X	X	X	X	X	X
HOT LINE MESSAGE	X	X	X	X	X	X	
CUSTOMER SUPPORT (24hrs)	12	X	X	12	X	X	8
ON LINE INFORMATION							
INTERNATIONAL RATES	X	X		X	X	X	
LOCAL PHONE NUMBERS	X	X	X	X		X	
NUMBER OF MESSAGES SENT		X					
USER DIRECTORIES	X	X			X	X	X
DATE/TIME		X	X			X	X
SPELLING CHECKER		X		X			
MESSAGE RETRIEVAL							
SEARCH BY DATE	X	X		X			
SEARCH BY SUBJECT	X	X		X			
READ BY NUMBER	X	X	X	X	X	X	
READ BY DATE	X	X		X			X
READ ALL	X	X	X	X			
READ BY SUBJECT	X	X		X			
UNREAD		X					
MESSAGE PURGE							
BY NUMBER	X	X	X	X	X		X
FROM USERNAME		X		X			
BY DATE		X		X			
BY SUBJECT		X		X			
UNPURGE		X		X			
MESSAGE ANSWERING							
ANSWER ALL	X	X			X		
ANSWER MESSAGE NUMBER	X	X	X	X	X	X	X
MESSAGE FORWARDING							
TO USER LIST	X	X				X	X
BY DATE		X					
FROM USERNAME	X	X					
BY MESSAGE NUMBER	X	X	X	X		X	X
WITH APPENDED COMMENTS	X	X		X			X
BY SUBJECT		X		X		X	
MESSAGE FILING							
BY USERNAME		X	X	X			
BY MESSAGE NUMBER	X	X		X	X		X
BY DATE		X		X			
REMOVE ALL	X	X		X			
REMOVE BY MESSAGE NUMBER	X	X		X	X		X
SEND MAIL							
BY DATE		X		X	X		
REPEAT SEND BY COUNT		X	X		X		
REPEAT SEND BY DATE/TIME		X	X		X		
RETURN RECEIPT REQUEST	X	X	X	X	X		X
SEND REGISTERED		X		X			
SEND URGENT	X	X		X		X	
SEND PRIVATE		X		X			
CANCEL SEND		X		X			
BLIND COPY				X	X		
BULLETIN BOARD	X	X	X	X	X		
USERCODE STURCTURE							
HIERARCHICAL		X	X				
LOW LEVEL QUALIFIER	X	X	X	X	X	X	X
PASSWORD MAINTENANCE	X	X	X	X	X		X
COMMAND DRIVEN	X	X	X	X	X	X	X
MENU DRIVEN	X	X		X			
BINARY FILE TRANSFER	X	X	X	X			
GATEWAY		X	X	X	X	X	X

TABLE 7-1 COMPARISON OF ELECTRONIC MAIL FEATURES

CARRIER	FEE	CONNECT CHARGE	STORAGE	DISCOUNTS	ACCESS PTS	CONTACT	COST/7200 CHARS	Message Hour
WESTERN UNION "EASYLINK"	$25/yr; 18/yr for each add'l user	AT 1200 bps: $0.50/min + $0.20/ address $0.30/min for WATS (800)	none for 5 days	10% if monthly billing over $1000	300+ cities	(800) 527-5184	$0.80 + $0.20 for first addressee	$60.00
MCI "MCI MAIL"	$18/yr per user	$0.45/ 0 - 500 chars $1.00/ 501 - 7500 chars $1.00 / ea add'l 7500 chars	none for 10 days	none	300+ cities	(202) 833-8484	$1.00	$60.00
McDonald Douglas "ONTYME"	$200/mo per account	$3.00/hr plus $0.25/k chars **	$0.01/1k chars/day	10% if monthly billing over $5000	300 + cities	(408) 942-5230	$1.60 plus $0.072 storage/ day	$110.00 **
US SPRINT "Telemail" *	$140/mo per account ($500.00 minimum)	$14/hr 7a.m.-6p.m.,$7 6-9p.m. $4/hr 9p.m.-6a.m. +$0.05/1000 $0.53/min for WATS (800) **	$0.007/day per 1000 char	negotiable	300+ cities	(703) 478-3040	$0.59 + $0.007 per 1000 char storage **	$70.80
DIALCOM "DIALCOM"	none	8:a-6:p $9/hr; else $5/hr loc $1,tymnet $5,telenet $6/hr	$0.20/2k after 2 month	GSA Schedule	300+ cities	(301) 488-0050	$1.15 + $1.00 per hr connect	$70.00
Graphnet, Inc	$15/mo per user	1200 bps: $0.80/min send only	none for 7 days	5% over $300 10% over $1000	300 + cities	(800) 336-3729	$0.80 **	$96.00 **

* See NASAMAIL Telenet contract for rate schedule
  NASAMAIL Administrator: Mike Kleminski, Huntsville, Ala. (205) 544-0134
  Mr. Kleminski says the following:
  1. Each NASA center projects their usage for the next fiscal year
  2. Headquarters' estimate was for 1200 mailboxes
  3. Most of those are assigned, but probably not in use
  4. NASAMAIL may be used by contractors if sponsored by NASA
  5. Mr Kleminski's NASAMAIL superior is Gail Posey, code N, HQ. (202) 453-2155

** For send and receive

TABLE 7-2: ELECTRONIC MAIL COST COMPARISON

7.3 ALTERNATIVE ELECTRONIC MAIL SYSTEM

The primary alternative to the NASAMAIL is the commercially available TELEMAIL. The cost is the lowest of the commercial vendors; however, access would be limited to the TU family and other subscribers of TELEMAIL. Use of TELEMAIL would not allow the NASA TU community to communicate directly with other members of the NASA research and development community.

The second alternative to NASAMAIL is DIALCOM. DIALCOM provides the majority of the features needed by TUNS, but again is limited to those subscribers of DIALCOM. The cost of DIALCOM is estimated to be $10 per message hour higher than TELEMAIL.

APPENDIX A

WORKSTATION SURVEY

WORKSTATION SURVEY

In order to obtain a consistent response among the workstation vendors, a minimum workstation configuration was defined based on the TUNS requirements. Seven vendors were then surveyed via telephone and asked to respond with a GSA price, if available, for the minimum configuration and to list options and other capabilities of the specified model. The results of the survey are presented in this appendix.

WORKSTATION

MANUFACTURER: AT & T   MODEL: 6300 PLUS

     VENDOR: COMPUTERLAND

   CPU: 80286

STANDARD CONFIGURATION
        o 640 Kb RAM
        o 1 high capacity floppy disk
        o 1 keyboard
        o 1 20 Mb hard disk
        o 4 16-bit empty slots
        o 1 serial port
        o 1 parallel port

   OPTIONS/CAPACITIES
        o Maximum RAM: 2 Mb
        o Maximum hard disk capacity available: 80 Mb
        o Clock speed 6 MHz, not software-selectable
        o 3.2 current version of MS-DOS available
        o I/O controller is an 8 bit board, 16-bit boards not IBM compatible

   Standard Configuraton

   GSA COST: $2,449

MANUFACTURER: <u>COMPAQ</u>   MODEL: <u>286-20, 286-40</u>

VENDOR: COMPUTERLAND

CPU: 80286

STANDARD CONFIGURATION
    o 640 Kb RAM
    o 1 high capacity floppy disk
    o 1 keyboard
    o 1 20 Mb hard disk
    o 4 16-bit empty slots
    o No serial port
    o No parallel port

OPTIONS/CAPACITIES
    o Maximum RAM: 1 Mb
    o Maximum hard disk capacity available: 40 Mb
    o Clock speed 8 MHz, is software-selectable
    o 3.2 current version of MS-DOS available

Standard Configuration   TUNS Configuration

GSA COST <u>$2,750</u>   GSA COST: <u>$3,349</u> Model 286-40

MANUFACTURER: COMPAQ   MODEL: 286-20,286-40

   VENDOR: ENTRE COMPUTER CENTER

   CPU: 80286

STANDARD CONFIGURATION
- 640 Kb RAM
- 1 high capacity floppy disk
- 1 keyboard
- 1 20 Mb hard disk
- 8 16-bit empty slots
- 1 serial port
- 1 parallel port

OPTIONS/CAPACITIES
- Maximum RAM: 8 Mb
- Maximum hard disk capacity available: 130 Mb
- Clock speed 8 MHz, is software-selectable
- 3.1 current version of MS-DOS available

Standard Configuration   TUNS configuration

GSA COST: $2,595   GSA COST: $3,119 Model 286-40

MANUFACTURER: COMPAQ   MODEL: 286-20, 286-40

    VENDOR: BUSINESSLAND

    CPU: 80286

STANDARD CONFIGURATION
- o 640 Kb RAM
- o 1 high capacity floppy disk
- o 1 keyboard
- o 1 20 Mb hard disk
- o 16-bit empty slots
- o 1 serial port
- o 1 parallel port

OPTIONS/CAPACITIES
- o Maximum RAM: 8 Mb
- o Maximum hard disk capacity available: 70 Mb
- o Clock speed 8 MHz & 6 MHz, is software-selectable
- o 3.1 current version of MS-DOS available

Standard Configuration   TUNS Configuration

GSA COST: $2,599   GSA COST: $3,249 Model 286-40

MANUFACTURER: COMPAQ   MODEL: 386-40

   VENDOR: BUSINESSLAND

   CPU: 80386

STANDARD CONFIGURATION
   o 1 Mb RAM
   o 1 high capacity floppy disk
   o 1 keyboard
   o 1 40 Mb hard disk
   o At least 1 32-bit empty slot
   o 1 serial port
   o 1 parallel port

OPTIONS/CAPACITIES
   o Maximum RAM: 14 Mb
   o Maximum hard disk capacity available: 130 Mb
   o Clock speed 16 MHz, is software-selectable
   o 3.1 current version of MS-DOS available

Standard configuration

GSA COST: $4,224

MANUFACTURER: <u>COMPAQ</u>   MODEL: <u>386-40</u>

VENDOR: ENTRE COMPUTER CENTER

CPU: 80386

STANDARD CONFIGURATION
- o 1 Mb RAM
- o 1 high capacity floppy disk
- o 1 keyboard
- o 1 40 Mb hard disk
- o 6 32-bit empty slots
- o 1 serial port
- o 1 parallel port

OPTIONS/CAPACITIES
- o Maximum RAM: 14 Mb
- o Maximum hard disk capacity available: 130 Mb
- o Clock speed 16 MHz, is software-selectable
- o 3.1 current version of MS-DOS available

Standard Configuration

GSA COST: <u>$4,224</u>

MANUFACTURER: <u>IBM</u>   MODEL: <u>AT</u>

   VENDOR: THE SOFTWARE STORE

   CPU: 80286

STANDARD CONFIGURATION
   o 512 Kb RAM
   o 1 high capacity floppy disk
   o 1 keyboard
   o 1 30 Mb hard disk
   o 7 16-bit empty slots
   o No serial port
   o No parallel port

OPTIONS/CAPACITIES
   o Maximum RAM: 2 Mb
   o Maximum hard disk capacity available: 60 Mb
   o Clock speed 6 MHz and 8 MHz, not software-selectable
   o 3.1 current version of MS-DOS available

Standard Configuration   TUNS Configuration

Government COST: <u>$2,995</u>   Government COST: <u>$3,395</u>

NOTE: IBM Product Centers are the only vendors authorized to provide GSA
         prices.

MANUFACTURER: <u>IBM</u>   MODEL: <u>AT</u>

VENDOR: IBM Product Center

CPU: 80286

STANDARD CONFIGURATION
- o 640 Kb RAM
- o 1 high capacity floppy disk
- o 1 keyboard
- o 1 30 Mb hard disk
- o 4 16-bit empty slots
- o 1 serial port
- o 1 parallel port

OPTIONS/CAPACITIES
- o Maximum RAM: 10.5 Mb
- o Maximum hard disk capacity available: 61.2 Mb
- o Clock speed 8 MHz, not software-selectable
- o 3.2 current version of MS-DOS available

TUNS Configuration
GSA PRICE: <u>$3,707</u>

NOTE: IBM Product Centers are the only vendors authorized to provide GSA prices.

MANUFACTURER: <u>KAYPRO</u>   MODEL: <u>386</u>

VENDOR: CCI

CPU: 80386

STANDARD CONFIGURATION
   o 640 Kb RAM
   o 1 high capacity floppy disk
   o 1 keyboard
   o 1 20 Mb hard disk
   o 6 32-bit empty slot
   o No serial port
   o No parallel port

OPTIONS/CAPACITIES
   o Maximum RAM: 16 Mb
   o Maximum hard disk capacity available: 660 Mb
   o Clock speed 16 MHz, not software-selectable
   o 3.2 current version of MS-DOS available

Standard Configuration

LIST PRICE: <u>$5,770</u>

NOTE: Vendor not on GSA schedule.

MANUFACTURER: KAYPRO   MODEL: 286

 VENDOR: CCI

 CPU: 80286

 STANDARD CONFIGURATION
   o 640 Kb RAM
   o 1 high capacity floppy disk
   o 1 keyboard
   o 1 20 Mb hard disk
   o 4 16-bit empty slots
   o No serial port
   o No parallel port
   o Monochrome monitor
   o Monochrome monitor card

 OPTIONS/CAPACITIES
   o Maximum RAM: 3 Mb
   o Maximum hard disk capacity available: 1 Mb
   o Clock speed 8 MHz
   o 3.2 current version of MS-DOS available

 Standard Configuration

 LIST PRICE: $2,901

 NOTE: Vendor not on GSA schedule.

WORKSTATION

MANUFACTURER: <u>RADIO SHACK</u>   MODEL: <u>Tandy 3000</u>

    VENDOR: Radio Shack

    CPU: 80286

    STANDARD CONFIGURATION
- o MS DOS 3.1 or later version
- o 512 Kb RAM
- o 1 keyboard
- o 1 20 Mb hard disk
- o 1 1.2 Mb floppy disk
- o 7 empty slots
- o 1 serial port
- o 1 parallel port

    Standard Configuration

    GSA PRICE: <u>$2,879.20</u>

MANUFACTURER: RADIO SHACK   MODEL: Tandy 3000

VENDOR: Radio Shack

CPU: 80286

STANDARD CONFIGURATION
   o MS DOS 3.1 or later version
   o 640 Kb RAM
   o 1 keyboard
   o 1 40 Mb hard disk
   o 1 1.2 Mb floppy disk
   o 7 empty slots
   o 1 serial port
   o 1 parallel port

OPTIONS/CAPACITIES
   o 80 Mb (2 40 Mb hard disks)

Standard Configuration

GSA PRICE: $3,439.20

WORKSTATION

MANUFACTURER: ZENITH   MODEL: ZF-248-81, ZW-248-84

    VENDOR: HEATH-ZENITH COMPUTERS

    CPU: 80286

    STANDARD CONFIGURATION
        o 512 Kb RAM
        o 1 high capacity floppy disk
        o 1 keyboard
        o 1 10 Mb hard disk
        o 7 32-bit empty slots
        o 1 serial port
        o 1 parallel port

    OPTIONS/CAPACITIES
        o Maximum RAM: 1.2 Mb
        o Maximum hard disk capacity available: 40 Mb
        o Clock speed 8 MHz, not software-selectable
        o 3.2 current version of MS-DOS available

Standard Configuration   TUNS Configuration

GSA COST: $1,709   GSA COST: $3,248

APPENDIX B

PRINTER SURVEY

Based on the TUNS functional and technical requirements, ISN conducted a survey of the dot-matrix, daisy-wheel, and laser printers currently available on the market. Five dot-matrix, six daisy-wheel, five laser, and two combination dot-matrix/daisy-wheel printers were selected for further evaluation. Information about these eighteen printers is presented in this appendix. Information from vendors was supplemented by published evaluation reports, including PC Magazine's special issue on printers, November 11, 1986.

DOT-MATRIX PRINTER

MANUFACTURER: <u>C.ITOH ELECTRONICS, INC.</u>   MODEL: <u>C-315 XP</u>

PAPER HANDLING
  o 15 1/2 inches maximum paper width

PRINTING CHARACTERISTICS
  o Near letter quality
  o Graphics capability
  o Resolution (HxV): 240 x 216 dpi
  o Print speed (cps):
        Normal mode 300
        NLQ mode 30
  o 9 pin

INTERFACE CHARACTERISTICS
  o Printer buffering available
        Buffer size 2 Kb standard, expandable to 10 Kb
  o Centronics parallel interface
  o Serial interface available

OTHER FEATURES
  o IBM Proprinter compatibility
  o Front-panel controls

LIST PRICE: <u>$819</u>

SOFTWARE CONTROL CAPABILITIES
  o Page length
  o Line length
  o Vertical tab
  o Horizontal tab
  o Underline
  o Superscript/subscript
  o Bold
  o Line spacing per inch

DOT-MATRIX PRINTER

MANUFACTURER: EPSON AMERICA INC.   MODEL: EPSON FX-286e

PAPER HANDLING
 o 16 1/4 inches maximum paper width

PRINTING CHARACTERISTICS
 o Near letter quality
 o Graphics capability
 o Resolution (HxV): 240 x 60 dpi
 o Print speed (cps):
   Normal mode 216
   NLQ mode 40

INTERFACE CHARACTERISTICS
 o Printer buffering available
   Buffer size 8 Kb
 o Centronics parallel interface
 o 9 pin

OTHER FEATURES
 o 10 different graphics modes

LIST PRICE: $799

SOFTWARE CONTROL CAPABILITIES
 o Page length
 o Vertical tab
 o Horizontal tab
 o Underline
 o Superscript/subscript
 o Bold
 o Italic
 o Double strike
 o Proportional spacing
 o Justified lines
 o Centered lines
 o Variable line heights
 o Extended/condensed
 o Correspondence quality

GSA COST: $527

DOT-MATRIX PRINTER

MANUFACTURER: <u>EPSON AMERICA INC.</u>   MODEL: <u>EPSON LQ-1000</u>

PAPER HANDLING
  o 16 1/4 inches maximum paper width

PRINTING CHARACTERISTICS
  o Near letter quality
  o Bidirectional printing
  o Graphics capability
  o Resolution (HxV): 360 X 60
  o Print speed (cps):
        Normal mode 180
        NLQ mode 52
  o 24 pins

INTERFACE CHARACTERISTICS
  o Centronics parallel interface
  o Serial interface available
  o Printer buffering available
        Buffer size 7 Kb

SOFTWARE CONTROL CAPABILITIES
  o Page length
  o Line length
  o Vertical tab
  o Horizontal tab
  o Underline
  o Superscript/subscript
  o Bold
  o Italic
  o Double strike
  o Identical to the Diablo 630,
     Epson, IBM 5051 printers

LIST PRICE: <u>$1,095</u>   GSA COST: <u>$729</u>

MANUFACTURER: <u>OKIDATA</u>   MODEL: <u>MICROLINE 193 Plus</u>

PAPER HANDLING
   o 16 1/4 inches maximum paper width

PRINTING CHARACTERISTICS
   o Near letter quality
   o Bidirectional printing
   o Graphics capability
   o Resolution (HxV): 288 x 144
   o Print speed (cps):
      Normal mode 200
      NLQ mode 36
   o 9 pin

INTERFACE CHARACTERISTICS
   o Centronics parallel interface
   o Serial interface available
   o Printer buffering available
         Buffer size: 8 Kb

SOFTWARE CONTROL CAPABILITIES
   o Page length
   o Vertical tab
   o Horizontal tab
   o Underline
   o Superscript/subscript
   o Bold
   o Italic
   o Compressed & wide type
   o Proportional spacing
   o Justified lines
   o Centered lines
   o Variable line heights
   o Identical to the IBM 5051
      printer

OTHER FEATURES
   o Paper feed either underneath or behind
   o Okifont - utility which allows you to pick from several different
      fonts or create your own.

LIST PRICE: <u>$795</u>

MANUFACTURER: <u>PANASONIC COMPUTER PRODUCTS DIV</u>   MODEL: <u>PANASONIC KX-P1595</u>

PAPER HANDLING
- o 17 inches maximum paper width

PRINTING CHARACTERISTICS
- o Near letter quality
- o Bidirectional printing
- o Graphics capability
- o Resolution (HxV): 240 x 72
- o Print speed (cps):
  Normal mode 240
  NLQ mode 42
- o 9 pin

INTERFACE CHARACTERISTICS
- o Centronics parallel interface
- o Serial interface available
- o Printer buffering available
    Buffer size: 1 Kb

LIST PRICE: <u>$949</u>

SOFTWARE CONTROL CAPABILITIES
- o Page length
- o Vertical tab
- o Horizontal tab
- o Underline
- o Superscript/subscript
- o Bold
- o Double strike
- o Centered lines
- o Proportional spacing
- o Justified lines
- o Centered lines
- o Variable line heights
- o Extended/condensed
- o Identical to the Epson, IBM 5152 printers

MANUFACTURER: BROTHER INTERNATIONAL CORP.   MODEL: HR-35

PAPER HANDLING
   o 8 1/2 inches maximum paper width

PRINTING CHARACTERISTICS
   o Bidirectional printing
   o Print speed (cps) 33

INTERFACE CHARACTERISTICS
   o Centronics parallel interface
   o Serial interface available
   o Printer buffering available:
         Buffer size 7 Kb

SOFTWARE CONTROL CAPABILITIES
   o Vertical tab
   o Horizontal tab
   o Underline
   o Superscript/subscript
   o Bold
   o Identical to the Diablo printer

LIST PRICE: $780

MANUFACTURER: <u>DIABLO</u>   MODEL: <u>635</u>

PAPER HANDLING
  o 16 1/2 inches maximum paper width

PRINTING CHARACTERISTICS
  o Bidirectional printing
  o Print speed (cps) 55

INTERFACE CHARACTERISTICS
  o Centronics parallel interface
  o Serial interface available
  o Printer buffering available

SOFTWARE CONTROL CAPABILITIES
  o Vertical tab
  o Horizontal tab
  o Underline
  o Superscript/subscript
  o Bold

LIST PRICE: <u>$1,149</u>   GOVERNMENT PRICE: <u>$853</u>

DAISY-WHEEL PRINTER

MANUFACTURER: <u>DIABLO</u>   MODEL: <u>D80IF</u>

PAPER HANDLING
   o 15 1/4 inches maximum paper width

PRINTING CHARACTERISTICS
   o Bidirectional printing
   o Print speed (cps) 80

INTERFACE CHARACTERISTICS
   o Printer buffering available
            Buffer size 1.5 Kb

SOFTWARE CONTROL CAPABILITIES
   o Vertical tab
   o Horizontal tab
   o Underline
   o Superscript/subscript
   o Bold

LIST PRICE: <u>$1,995</u>   GOVERNMENT PRICE: <u>$1,523</u>

MANUFACTURER: ITT QUME CORP   MODEL: QUME LETTER PRO PLUS

PAPER HANDLING
   o 12 inches maximum paper width

PRINTING CHARACTERISTICS
   o Bidirectional printing
   o Print speed (cps) 45

INTERFACE CHARACTERISTICS
   o Centronics parallel interface
   o Serial interface available
   o Printer buffering available
            Buffer size: 25 Kb

SOFTWARE CONTROL CAPABILITIES
   o Page length
   o Vertical tab
   o Horizontal tab
   o Underline
   o Superscript/subscript
   o Bold
   o Double strike
   o Line spacing per inch
   o Identical to the Diablo 630 printer

LIST PRICE: $899

MANUFACTURER: <u>NEC</u>   MODEL: <u>3515</u>

PAPER HANDLING
   o 14 1/2 inches maximum paper width

PRINTING CHARACTERISTICS
   o Bidirectional printing
   o Print speed (cps) 32

SOFTWARE CONTROL CAPABILITIES
   o Vertical tab
   o Horizontal tab
   o Underline
   o Superscript/subscript
   o Bold
   o Identical to the Diablo printer

LIST PRICE: <u>$865</u>

DAISY-WHEEL PRINTER

MANUFACTURER: <u>OLYMPIA</u>   MODEL: <u>ESW 1000 C</u>

PAPER HANDLING
  o 14 3/4 inches maximum paper width

PRINTING CHARACTERISTICS
  o Bidirectional printing
  o Print speed (cps) 15

INTERFACE CHARACTERISTICS
  o Centronics parallel interface
  o Serial interface available
  o Printer buffering available
        Buffer size: 2 Kb

SOFTWARE CONTROL CAPABILITIES
  o Page length
  o Vertical tab
  o Horizontal tab
  o Underline
  o Superscript/subscript
  o Bold
  o Double strike
  o Justified line
  o Centered line
  o Line spacing per inch
  o Identical to the Diablo 630 printer

LIST PRICE: <u>$549</u>

COMBINED DOT-MATRIX AND DAISY-WHEEL PRINTER

MANUFACTURER: <u>BROTHER INTERNATIONAL CORP.</u>   MODEL: <u>TWINWRITER 5</u>

PAPER HANDLING
  o 15 1/4 inches maximum paper width

PRINTING CHARACTERISTICS
  o Letter quality
  o Bidirectional printing
  o Graphics capability
  o Down-loading of fonts
  o Print speed (cps):
          Normal mode 140
          NLQ mode 54
          Daisy-wheel mode 36

INTERFACE CHARACTERISTICS
  o Printer buffering available
          Buffer size: 3 Kb

SOFTWARE CONTROL CAPABILITIES
  o Vertical tab
  o Horizontal tab
  o Underline
  o Bold
  o Italic
  o Double strike
  o Superscript/subscript
  o Extended/condensed
  o Identical to the Diablo 630, Epson printers

LIST PRICE: <u>$1,295</u>

COMBINED DOT-MATRIX AND DAISY-WHEEL PRINTER

MANUFACTURER: FORTIS COMPUTER SYSTEMS   MODEL: DH-45

PAPER HANDLING
   o 17 inches maximum paper width

PRINTING CHARACTERISTICS
   o Letter quality
   o Graphics capability
   o Print speed (cps):
            Normal mode 140
            Daisy-wheel mode 36
   o 9 pin

SOFTWARE CONTROL CAPABILITIES
   o Page length
   o Vertical tab
   o Horizontal tab
   o Underline
   o Bold
   o Superscript/subscript

OTHER FEATURES
   o 14 different fonts

LIST PRICE: $1,295

MANUFACTURER: <u>BLASER INDUSTRIES</u>   MODEL: <u>THE BLASER</u>

PAPER HANDLING
  o 8 1/2 inches maximum paper width

PRINTING CHARACTERISTICS
  o Graphics capability
  o Maximum 8 fonts per page
  o Print speed 8 pages per minute

INTERFACE CHARACTERISTICS
  o Centronics parallel interface
  o Serial interface available

SOFTWARE CONTROL CAPABILITIES
  o Page length
  o Vertical tab
  o Horizontal tab
  o Underline
  o Bold
  o Superscript/subscript
  o Line height
  o Compress
  o Line spacing per inch
  o Identical to the IBM Proprinter
  o Prints up to 256 copies of a document
  o Similar to the Hewlett-Packard Laserjet

LIST PRICE: <u>$2795</u>

LASER PRINTER

MANUFACTURER: HEWLETT-PACKARD   MODEL: LASERJET SERIES II

PAPER HANDLING
   o 8 1/2 inches maximum paper width

PRINTING CHARACTERISTICS
   o Letter quality resolution:
        300 X 300 dpi
   o Graphics capability
   o Forms capability
   o Forms overlay
   o Maximum 8 fonts per page
   o Down loading fonts
   o Print speed 8 pages per minute

INTERFACE CHARACTERISTICS
   o Centronics parallel interface
   o Serial interface available

SOFTWARE CONTROL CAPABILITIES
   o Vertical tab
   o Horizontal tab
   o Bold
   o Superscript/subscript

LIST PRICE: $2,495   GOVERNMENT PRICE: $1,795

SUPPLIES: $119 per 4,000 pages

LASER PRINTER

MANUFACTURER: HEWLETT-PACKARD   MODEL: LASERJET 500 PLUS

PAPER HANDLING
   o 8 1/2 inches maximum paper width

PRINTING CHARACTERISTICS
   o Letter quality resolution:
            300 X 300 dpi
   o Graphics capability
   o Maximum 16 fonts per page
   o Down loading fonts
   o Print speed 8 pages per minute

INTERFACE CHARACTERISTICS
   o Centronics parallel interface
   o Serial interface available

SOFTWARE CONTROL CAPABILITIES
   o Page length
   o Vertical tab
   o Horizontal tab
   o Superscript/subscript
   o Bold
   o Line height
   o Canon engine
   o Identical to the Hewlett-Packard Laserjet and the Hewlett-Packard
      Laserjet Plus

LIST PRICE: $4,995

LASER PRINTER

MANUFACTURER: <u>OKIDATA</u>   MODEL: <u>LASERLINE 6</u>

PAPER HANDLING
   o 8 1/2 inchs maximum paper width

PRINTING CHARACTERISTICS
   o Letter quality resolution:
         300 X 300 dpi
   o Graphics capability
   o Down loading fonts
   o Print speed 6 pages per minute

INTERFACE CHARACTERISTICS
   o Centronics parallel interface
   o Serial interface available
   o Printer buffering available
         Buffer size: 272 Kb

SOFTWARE CONTROL CAPABILITIES
   o Vertical tab
   o Horizontal tab
   o Superscript/subscript
   o Bold
   o Ricoh engine
   o 15 different fonts
   o H-P Laserjet compatible
   o Diablo, NEC, Qume, Epson, and IBM Graphics printer emulations
   o Includes software control program

LIST PRICE: <u>$1,995</u>

SUPPLIES: toner $29 per 1,000 pages
           drum/cartridge $199 per 10,000 pages

LASER PRINTER

MANUFACTURER: <u>QMS INCORPORATED</u>   MODEL: <u>QMS KISS</u>

PAPER HANDLING
  o 8 1/2 inches maximum paper width

PRINTING CHARACTERISTICS
  o Letter quality resolution:
        300 X 300 dpi
  o Graphics capability
  o Down loading fonts
  o Print speed 8 pages per minute

INTERFACE CHARACTERISTICS
  o Centronics parallel interface
  o Serial interface available
  o Printer buffering available
        Buffer size: 128 Kb

SOFTWARE CONTROL CAPABILITIES
  o Page length
  o Vertical tab
  o Horizontal tab
  o Underline
  o Superscript/subscript
  o Bold
  o Double strike
  o Canon engine
  o 12 different fonts
  o Diablo 630, Epson FX-80, Qume Sprint printer emulations

LIST PRICE: <u>$1,995</u>   GOVERNMENT PRICE: <u>$1,795</u>

SUPPLIES: $99 per 3,000 pages

APPENDIX C

COMMUNICATIONS DEVICE (MODEM) SURVEY

MODEM SURVEY

Two sources were used to select modems for evaluation for possible inclusion in TUNS: (1) descriptions in PC Tech Journal's 1987 "Comprehensive Product Guide"; (2) reports in Datapro Reports on Data Communications. Seven modems were selected for further review. Information obtained from the vendors and the resources listed above is summarized in this appendix.

MANUFACTURER: <u>ANDERSON JACOBSON, INC</u>.   MODEL: <u>AJ Connection II</u>

CAPABILITIES
- o Hayes compatible
- o 300 baud rate
- o 1200 baud rate
- o 2400 baud rate
- o Full duplex
- o Half duplex
- o Asynchronous
- o Synchronous
- o Auto dial
- o Auto answer

FEATURES
- o AJ superset command
- o Auto lock
- o Callback security

LIST PRICE: <u>$650</u>   GSA COST: <u>$520</u>

MANUFACTURER: <u>HAYES MICROCOMPUTER PRODUCTS, INC</u>. MODEL: <u>HAYES SMARTMODEM 2400</u>

CAPABILITIES
- o 300 baud rate
- o 1200 baud rate
- o 2400 baud rate
- o Full duplex
- o Half duplex
- o Asynchronous
- o Synchronous
- o Auto dial
- o Auto answer

FEATURES
- o External or internal

LIST PRICE: <u>$739</u>   GSA COST: <u>$579</u>

MODEM

MANUFACTURER: <u>INCOMM DATA SYSTEMS, INC.</u>   MODEL: <u>TURBO 2400</u>

CAPABILITIES
    o Hayes compatible
    o 300 baud rate
    o 600 baud rate
    o 1200 baud rate
    o 2400 baud rate
    o Full duplex
    o Half duplex
    o Asynchronous
    o Synchronous
    o Auto Dial
    o Auto Answer

FEATURES:
    o Five years guarantee
    o Upgrade to 4800 baud available for external modem

LIST PRICE: <u>$449</u>   GSA COST: <u>$315</u>

MODEM

MANUFACTURER: <u>LINK COMPUTER, INC</u>.   MODEL: <u>SM-24PC</u>

CAPABILITIES
        o Hayes compatible
        o 300 baud rate
        o 600 baud rate
        o 1200 baud rate
        o 2400 baud rate
        o Full duplex
        o Half duplex
        o Asynchronous
        o Synchronous
        o Auto dial
        o Auto answer

FEATURES
        o The only vendor for Link modems
        o Not on GSA schedule

LIST PRICE: <u>$579</u>   GOVERNMENT PRICE: <u>$230</u>

MANUFACTURER: MICROCOM, INC.   MODEL: AX/2400

CAPABILITIES
     o Hayes compatible
     o 300 baud rate
     o 1200 baud rate
     o 2400 baud rate
     o Full duplex
     o Half duplex
     o Asynchronous
     o Synchronous
     o Auto dial
     o Auto answer

FEATURES
     o Hayes compatible includes software
     o Also compatible with other modems

LIST PRICE: $749   GSA COST: $595

MANUFACTURER: MULTI-TECH SYSTEMS, INC.   MODEL: MULTIMODEM 224PC

CAPABILITIES
    o Hayes compatible
    o 300 baud rate
    o 1200 baud rate
    o 2400 baud rate
    o Full duplex
    o Half duplex
    o Asynchronous
    o Synchronous
    o Auto dial
    o Auto answer

FEATURES
    o Software included

LIST PRICE: $649   GSA COST: $426

MANUFACTURER: <u>PARADYNE, CORP</u>.   MODEL: <u>FDX 2400</u>

CAPABILITIES

  o Hayes compatible

  o 300 baud rate

  o 600 baud rate

  o 1200 baud rate

  o 2400 baud rate

  o Full duplex

  o Half duplex

  o Asynchronous

  o Synchronous

  o Auto dial

  o Auto answer

FEATURES

  o Includes software

  o Software programmer interface

LIST PRICE: <u>$495</u>   GSA COST: <u>$396</u>

APPENDIX D

TAPE BACKUP DEVICE SURVEY

TAPE BACKUP DEVICE SURVEY

Tape backup device vendors were interviewed over the telephone, using a survey developed by ISN. Vendors were asked specific questions about the capabilities and costs of their products. This information was supplemented with the benchmark results published in the October 1986 BYTE magazine. This appendix contains a summary of nine different tape backup devices from seven different vendors. Pricing information is not included for those products which were eliminated for reasons other than cost.

TAPE BACKUP DEVICE

MANUFACTURER: <u>ALLOY COMPUTER PRODUCTS INC.</u>   MODEL: <u>FT-60</u>

KIND OF TAPE UNIT
- o Cartridge

COMPUTER INTERFACE
- o AT compatible
- o Disk controller required
- o 256 Kb RAM needed

TAPE/DEVICE CHARACTERISTICS
- o 60 Mb capacity
- o Tape formatting required once
- o 12 recording tracks

BACKUP/RESTORE SOFTWARE
- o Menu, command software control
- o Automatic backup
- o Backup by:
  - directory
  - file-by-file
  - date/time
- o Restore by:
  - directory
  - file-by-file
- o Backup benchmark: 200 files, 1 Kb each = 2 minutes, 15 seconds
- o Restore benchmark: 200 files, 1 Kb each = 10 minutes, 30 seconds
- o Backup reporting: directory listing

LAN INTERFACE
- o Not compatible with Novell Advanced NetWare/286

VENDOR: <u>ALLOY COMPUTER PRO</u>   MODEL: <u>PC-9 TRACK</u>

KIND OF TAPE UNIT
 o Reel

COMPUTER INTERFACE
 o AT compatible

TAPE/DEVICE CHARACTERISTICS
 o 42 Mb capacity
 o Data transfer rate: 1 to 7 Mb per minute data transfer rate

BACKUP/RESTORE SOFTWARE
 o Menu, command software control
 o Automatic backup
 o Backup by:
   directory
   file-by-file
   since last backup
   date/time
 o Restore by:
   directory
   file-by-file
   entire tape
   date/time

LAN INTERFACE
 o **Not compatible with Novell Advanced NetWare/286**

TAPE BACKUP DEVICE

VENDOR: <u>EMERALD SYSTEMS CORP</u>   MODEL: <u>LAN-2200</u>

KIND OF TAPE UNIT
- o Cartridge

COMPUTER INTERFACE
- o AT compatible
- o One expansion slot required
- o One 5 1/4 inch chassis position required
- o 256 Kb RAM needed

TAPE/DEVICE CHARACTERISTICS
- o 60 Mb to 240 Mb capacity
- o Data transfer rate: 90 Kb bps
- o Tape formatting required once
- o 9 recording tracks

BACKUP/RESTORE SOFTWARE
- o Automatic backup
- o On-line backup
- o Backup by:
        directory
        file-by-file
        date/time
- o Restore by:
        directory
        file-by-file
        entire tape
        date/time
- o Backup reporting: directory listing

LAN INTERFACE
- o Not compatible with Novell Advanced NetWare/286

TAPE BACKUP DEVICE

MANUFACTURER: <u>EMERALD SYSTEM CORP.</u>   MODEL: <u>LAN-9100</u>

KIND OF TAPE UNIT
   o Cartridge

COMPUTER INTERFACE
   o AT & XT compatible
   o One expansion slot required
   o 256 Kb RAM needed

TAPE/DEVICE CHARACTERISTICS
   o 60 Mb to 120 Mb capacity
   o Data transfer rate: 90 Kb bps
   o 15 recording tracks

BACKUP/RESTORE SOFTWARE
   o Menu, command software control
   o Automatic backup
   o On-line backup
   o Backup by:
           directory
           file-by-file
           date/time
   o Restore by:
           entire tape
           file-by-file
   o Backup benchmark: file by file, 2.5 Mb = 1 minute
   o Backup reporting: status log file

LAN INTERFACE
   o Available under Novell Advanced NetWare/286

GSA COST: <u>$1,496</u> (60 Mb)
           <u>$2,246</u> (120 Mb)

VENDOR: <u>GENOA SYSTEMS CORP</u>   MODEL: <u>GENOA GALAXY</u>

KIND OF TAPE UNIT
   o Cartridge

COMPUTER INTERFACE
   o AT compatible

TAPE/DEVICE CHARACTERISTICS
   o 60 Mb capacity

BACKUP/RESTORE SOFTWARE
   o Software provided
   o Menu software control
   o Automatic backup
   o Backup by:
         file-by-file
         image
   o Restore by:
         file-by-file
         image
   o Backup benchmark: 20 Mb = 4 minutes

LAN INTERFACE
   o Available under Novell Advanced NetWare/286
   o Requires purchase of GENWARE backup software for backup of hidden files

GSA COST: <u>$ 999</u>
 GENWARE: <u>$ 126</u>

VENDOR: <u>SYSGEN INC</u>   MODEL: <u>SMART QIC-FILE</u>

KIND OF TAPE UNIT
   o Cartridge

COMPUTER INTERFACE
   o AT compatible
   o One expansion slot required
   o 192 Kb RAM needed

TAPE/DEVICE CHARACTERISTICS
   o 60 Mb capacity
   o Data transfer rate:
          3 to 5 Mb per minute, image
          1 to 3 Mb per minute, file-by-file
   o 9 recording tracks

BACKUP/RESTORE SOFTWARE
   o Menu, command software control
   o Automatic backup
   o Backup by:
          directory
          file-by-file
          date/time
   o Restore by:
          directory
          file-by-file
          date/time
   o Backup benchmark: 200 files, 1 Kb each = 3 minutes, 15 seconds
   o Restore benchmark: 200 files, 1 Kb each = 9 minutes, 20 seconds
   o Backup reporting: Directory listing

LAN INTERFACE
   o Unreliable under Novell Advanced NetWare/286

TAPE BACKUP DEVICE

VENDOR: <u>TALLGRASS TECHNOLOGIES</u>   MODEL: <u>TG-4060</u>

KIND OF TAPE UNIT
   o Cartridge

COMPUTER INTERFACE
   o AT compatible
   o One expansion slot required
   o 256 Kb RAM needed

TAPE/DEVICE CHARACTERISTICS
   o 60 Mb to 80 Mb capacity
   o Tape formatting required once
   o 11 recording tracks

BACKUP/RESTORE SOFTWARE
   o Command software control
   o Backup by:
       directory
       file-by-file
       date/time
   o Restore by:
       directory
       file-by-file
       entire tape
   o Backup benchmark: 200 files, 1 Kb each = 1 minute, 27 seconds
   o Restore benchmark: 200 files, 1 Kb each = 2 minutes, 05 seconds
   o Backup reporting: Directory listing of hard disk and tape drive

LAN INTERFACE
   o Available under Novell Advanced NetWare/286
   o Requires purchase of separate controller

GSA COST: <u>$1,356</u>

TAPE BACKUP DEVICE

VENDOR: TECH USA   MODEL: PC 10-12

KIND OF TAPE UNIT
   o Reel

COMPUTER INTERFACE
   o AT, XT and Compaq 386 compatible

TAPE/DEVICE CHARACTERISTICS
   o 50 Mb capacity
   o Data transfer rate: 125 inches/second

BACKUP/RESTORE SOFTWARE
   o Menu, command software control
   o Automatic backup
   o Backup by:
          directory
          file-by-file
   o Restore by:
          file-by-file
          entire tape

LAN INTERFACE
   o Not compatible with Novell Advanced NetWare/286

TAPE BACKUP DEVICE

VENDOR: <u>TECMAR INC</u>   MODEL: <u>QIC-60H</u>

KIND OF TAPE UNIT
o Cartridge

COMPUTER INTERFACE
o AT compatible

o One expansion slot required

o 448 Kb RAM needed

TAPE/DEVICE CHARACTERISTICS
o 60 Mb capacity

o Tape formatting required each time used

o 9 recording tracks

BACKUP/RESTORE SOFTWARE
o Menu, command software control

o Backup by:

      directory

      file-by-file

      date/time

o Restore by:

      directory

      file-by-file

o Backup benchmark: 200 files, 1 Kb each = 1 minute, 21 seconds

o Restore benchmark: 200 files, 1 Kb each = 2 minutes, 10 seconds

o Backup reporting: directory listing

LAN INTERFACE
o Available for LAN

APPENDIX E

LAN HARDWARE SURVEY

Eleven manufacturers were surveyed by ISN for information about fourteen currently available LAN hardware devices. Vendors were asked specific questions to ascertain each product's ability to meet the TUNS functional and technical requirements. Additional information about these products was obtained from published evaluations including the PC Magazine series entitled "Making Connections", and the Auerbach Technology Report series contained in Datacomm Equipment. This appendix contains a summary of the LAN hardware products evaluated for possible inclusion in TUNS.

MANUFACTURER: 3COM   NETWORK: ETHERSERIES

PHYSICAL

    o Topology:

        Bus

    o Cable medium:

        Coaxial (thin or standard 50-ohm)

    o CSMA/CD line access method

    o Data type:

        Digital

    o Maximum transmission speed (bps):

        10 M

    o Maximum devices:

        1,000

    o Industry architecture:

        IBM

        Ethernet

    o Communications protocols:

        Async

        3270 gateway optional

SOFTWARE COMPATIBILITY

    o Novell NetWare

    o 3Com 3+ Share

COMPONENTS AND COSTS (GSA)

    o Etherlink card: $ 595   GSA Cost: $451
    o Etherlink Plus card: $ 859   GSA Cost: $651
    o 3Server3 file server: $4,540
    o Network software: 3+ Share (unlimited users) $1,149
                Etherseries $546

MANUFACTURER: <u>AST RESEARCH</u>   NETWORK: <u>AST RESOURCE SHARING</u>

PHYSICAL
- o Topology:
    - Bus
- o Cable medium:
    - Coaxial (RG-59)
- o CSMA/CD line access method
- o Data type:
    - Digital
- o Maximum transmission speed (bps):
    - 5 M
- o Maximum devices:
    - 64
- o Maximum distance between nodes:
    - 1,500 ft.
- o Industry architecture:
    - IBM NETBIOS
- o Communications protocols:
    - Bisync SNA

SOFTWARE COMPATIBILITY
- o Novell NetWare

COMPONENTS AND COSTS
- o 20 ft. cable: <u>$ 30</u>
- o Starter kit: <u>$1,295</u>
    - 2 adaptors, NETBIOS, 2 network programs
- o Adaptor: <u>$ 495</u>

MANUFACTURER: <u>AST RESEARCH</u>   NETWORK: <u>AST-PCNET II</u>

PHYSICAL

    o Topology:

        Bus

    o Cable medium:

        Twisted pair

    o CSMA/CA line access method

    o Data type:

        Digital

    o Maximum transmission speed (bps):

        800

    o Maximum devices:

        160

    o Maximum distance between nodes:

        500 ft.

    o Industry architecture:

        IBM NETBIOS

    o Communications protocols:

        HDLC

        SNA

SOFTWARE COMPATIBILITY

    o Novell NetWare

    o Microsoft Networks

    o IBM NETBIOS OS

COMPONENTS AND COSTS

   Starter Kit: <u>$1,090</u>

      2 interface boards, software, cable, manual

   Interface board: <u>$ 495</u>

   50 ft. cable: <u>$ 25</u>

LAN HARDWARE

MANUFACTURER: AT&T/IS   NETWORK: STARLAN

PHYSICAL
    o Topology:
            Daisy
            Star
    o Cable medium:
            Twisted pair
    o CSMA/CS line access method
    o Data types:
            Digital
            Voice
    o Maximum transmission speed (bps):
            1 M
    o Maximum devices:
            1,120
    o Maximum distance between nodes:
            Daisy: 400 ft.
            Star: N/A
    o Industry architecture:
            IBM
    o Communications protocols:
            Asynchronous

SOFTWARE COMPATIBILITY
    o Vendor-provided software
    o Novell NetWare

COMPONENTS AND COSTS
    o Centralized unit: $437 (for 11 workstations)
    o PC net access unit: $437

LAN HARDWARE

MANUFACTURER: BANYAN SYSTEMS   NETWORK: VINES

COMMENTS

    o Banyon markets file servers and software for use on a variety of LANS

PHYSICAL

    o Maximum devices:

        30 per server

        Multiple servers per LAN

    o Communications protocols:

        Asynchronous

        HDLC/SDLC

COMPONENTS AND COSTS

    o File server:

        43 Mb $11,245

        70 Mb $12,245

        120 Mb $16,245

    o 50 ft. cable $50

    o File sharing & print $1,895

MANUFACTURER: <u>FOX RESEARCH</u>   NETWORK: <u>10-NET</u>

PHYSICAL

    o Topology:

         Bus

    o Cable medium:

         Twisted pair

    o CSMA/CA line access method

    o Data type:

         Digital

    o Maximum transmission speed (bps):

         1 M

    o Maximum devices:

         Unlimited

    o Maximum distance between modes:

         2,000 ft.

         10,000 ft. with repeaters

    o Industry architecture:

         Ethernet

SOFTWARE COMPATIBILITY

    o Requires vendor-provided software, 10-net

COMPONENTS AND COSTS

    o Interface board, tap box, software: <u>$695</u>

    o Cable: <u>25¢</u>/ft.

LAN HARDWARE

MANUFACTURER: IBM   NETWORK: PC-NETWORK

PHYSICAL
    o Topology:
            Tree
    o Cable medium:
            Broadband coaxial
    o CSMA/CD line access method
    o Data type:
            Digital
            Video
    o Maximum transmission speed (bps):
            2 M
    o Maximum devices:
            72 with network expander unit
    o Maximum distance between modes:
            1,000 ft.
    o Industry architecture:
            IBM NETBIOS
    o Communications protocol:
            Asynchronous
    o Software compatibility:
            Novell Advanced NetWare

COMPONENTS AND COSTS
    o PC adaptor: $386
    o Translator unit: $409
    o PC network base expander: $ 45
    o 25 ft. cable: $ 24

LAN HARDWARE

MANUFACTURER: IBM   NETWORK: TOKEN RING LAN

PHYSICAL
    o Topology:

        Ring

    o Cable medium:

        Twisted pair

    o Token-passing line access method

    o Data type:

        Digital

    o Maximum transmission speed (bps):

        4 M

    o Maximum devices:

        72 with standard cabling

        260 with expansion units

    o Industry architecture:

        IBM

        IEEE 802.2, 802.5

    o Communications protocol:

        Asynchronous

        SNA 3270

        SDLC

    o Software compatibility:

        Novell Advanced NetWare

COMPONENTS AND COSTS
    o PC adaptor: $595
    o Cable adaptor: $ 27
    o Multi-station access unit: $660
    o NETBIOS software: $ 29
    o Token ring/PC network inter-connect program: $374

LAN HARDWARE

MANUFACTURER: <u>LEE DATA</u>   NETWORK: <u>ARCNET</u>

PHYSICAL
- o Topology:
     Ring
- o Cable medium:
     Twisted pair
- o Token-passing line access method
- o Data type:
     Digital
- o Maximum transmission speed (bps):
     2.5 M
- o Maximum devices:
     255
- o Maximum distance between nodes:
     2,000 ft.
- o Industry architecture:
     Ethernet
- o Communications protocol:
     Asynchronous
     SNA

SOFTWARE COMPATIBILITY
- o Requires vendor-provided software, LANMASTER

COMPONENTS AND COSTS

o Network server:	<u>$15,600</u>		o Console cable:	<u>$ 55</u>
o Interface board:	<u>$ 495</u>		o Software for server:	<u>$1,000</u>
o Cables:			o Active hub (8 ports):	<u>$ 790</u>
50ft. <u>$42</u>				

MANUFACTURER: <u>NOVELL</u>   NETWORK: <u>ETHERNET</u>

COMMENTS:
  o Interface card is 3Com Ethernet card
  o All Novell LANS use other vendors' hardware for interface cards
PHYSICAL
  o Topology:
        Bus
  o Cable medium:
        Coaxial (thin or standard 50-ohm)
  o CSMA/CD line access method
  o Data type:
        Digital
  o Maximum transmission speed (bps):
        10 M
  o Maximum devices:
        100 per file server
  o Industry architecture:
        Ethernet
  o Communications protocol:
        Proprietary

COMPONENTS AND COSTS
  o Interface card: <u>$595</u>   (GSA cost: <u>$524</u>)

MANUFACTURER: <u>ORCHID TECHNOLOGY</u>   NETWORK: <u>PC NET</u>

PHYSICAL
    o Topology:
            Bus
    o Cable medium:
            Coaxial (thin or standard 50-ohm)
    o CSMA/CD line access method
    o Data type:
            Digital
    o Maximum transmission speed (bps):
            1 M
    o Maximum devices:
            255
    o Maximum distance between nodes:
            7,000 ft.
    o Industry architecture:
            IBM
    o Communications protocol:
            Asynchronous
            Bisynchronous
            HDLC

SOFTWARE COMPATIBILITY
    o PC Net
    o Novell Advanced NetWare

COMPONENTS AND COSTS   (30% off for government)
    o PC starter kit (2 workstations): <u>$1,090</u>
    o 2 PC net boards: <u>$1,550</u>
    o Adaptor: <u>$ 495</u>

MANUFACTURER: <u>QUADRAM CORP</u>   NETWORK: <u>QUADNET VI</u>

PHYSICAL

- o Topology:

    Star

- o Cable medium:

    Coaxial (thin or standard 50-ohm)

- o CSMA/CD/CA line access method

- o Data type:

    Digital

- o Maximum transmission speed (bps):

    10 M

- o Maximum devices:

    Unlimited

- o Communications protocol:

    Asynchronous

SOFTWARE COMPATIBILITY

- o Vendor-provided software, requires Novell Advanced NetWare

COMPONENTS AND COSTS

- o Network interface card: <u>$ 795</u>

MANUFACTURER: <u>STANDARD MICRO SYSTEMS</u>   NETWORK: <u>ARCNET</u>

PHYSICAL

     o Topology:

           Ring

     o Cable medium:

           Coaxial (RG62/V)

     o Token-passing line access method

     o Data type:

           Digital

     o Maximum transmission speed (bps):

           2.5 M

     o Maximum devices:

           255

     o Maximum distance between nodes:

           2,000 ft.

     o Industry architecture:

           Datapoint ARCNET

COMPONENTS AND COSTS

     o Operating system: <u>$1,954</u>

     o Active hub (8 ports): <u>$ 788</u>

     o PC interface board: <u>$ 485</u>

     o 20 ft. cable: <u>$ 37</u>

APPENDIX F

LAN SOFTWARE SURVEY

ISN interviewed the manufacturer's representatives for six LAN software products. Vendors were asked specific questions about the software's capabilities as they pertain to the TUNS functional and technical requirements. Information provided by vendors was supplemented by published evaluation reports. The reports included the PC Magazine series entitled "Making Connections" which began in the December 9, 1986 issue, and those evaluations reported in the Auerbach Technology Report series contained in Datacomm Equipment. This appendix contains a summary of the information obtained about five of the six LAN software products. The AST Network Program product was not included here due to the fact that the software comes bundled with the hardware. GSA pricing was not provided by Banyan or Lee Data.

LAN SOFTWARE

MANUFACTURER: BANYAN SYSTEMS   NETWORK: VINES/286

OPERATING SYSTEM INTERFACE
    o Full NETBIOS support/emulation
    o MS-DOS Lock/Unlock (INT 21, 5C)
    o DOS 2.0+, DOS 3.0+ workstation operating system

GENERAL FUNCTIONALITY
    o LAN hardware supported by software:
            Allen-Bradley VistaLan   Proteon Pronet
            IBM Token Ring   IBM PC Net
            Convus Omninet   Nestar Arcnet
            3 Com Ethernet   Ungerman-Bass Ethernet
            Inter-LAN Ethernet
            Standard Micro Systems ARCNET
    o Additional hardware devices supported by software:
            Site-to-site connections over dial or leased lines using
            asynchronous or synchronous (HDLC) protocol.
            Remote PC dial-in
    o Additional software available:
            System administration
            Print and file sharing capabilities
    o Security provided by software:
            Full security so only authorized users can access resources
    o Other software features:
            Electronic mail standard
            Network-wide naming and addressing system
            Integrates multiple communications technologies
            Makes network resources appear as transparent extensions to
            local PC resources
            Permits environmental growth and easy expansion

LIST PRICE: $1,895   GSA COST: Not provided

LAN SOFTWARE

MANUFACTURER: <u>FOX RESEARCH CORP</u>   NETWORK: <u>10-NET</u>

OPERATING SYSTEM INTERFACE
     o MS-DOS Lock/Unlock (INT 21, 5C)
     o DOS 3.0+ workstation operating system

GENERAL FUNCTIONALITY
     o LAN hardware supported by software:
          10-Net hardware only
     o Software requirements when adding new nodes:
          Need 10-Net board
     o Hardware limitations imposed by software:
          Must have a repeater when using more than 32 workstations
     o Security provided by software:
          Directory rights, read and write files
          Set level of password
     o Other software features:
          Electronic mail
          Calendar
          Utilities
     o Additional software available:
          10-Net database
          Gateway communication

COST: <u>$695</u> (software bundled with hardware)

LIST PRICE: <u>$695</u> (includes hardware)   GSA COST: Not available on GSA schedule

MANUFACTURER: <u>LEE DATA</u>   NETWORK: <u>LANMASTER</u>

OPERATING SYSTEM INTERFACE
    o Full NETBIOS support/emulation
    o MS-DOS Lock/Unlock (INT 21, 5C)
    o DOS 2.0+, DOS 3.0+, UNIX workstation operating system

GENERAL FUNCTIONALITY
    o LAN hardware supported by software:

3Com Etherlink Plus	Ungermann Bass Net/One
IBM PC Net	Omninet
ARCNET	IBM Token Ring

    o Dedicated file servers supported
    o Inter-LAN operability supported:
        Between like LANs
    o Additional hardware devices supported by software:
        Shared modem
        Server to server
        Remote dial-in
        Server to host
        Network to network
    o Security provided by software:
        System administrator assigns passwords and user profiles
    o Other software features:
        Electronic mail standard
        Spooled printer sharing
        Network management (detail diagnostic tools)
        Backup and recovery files
        Bundled with file server

LIST PRICE: <u>$1,000</u>   GSA COST: Not provided

LAN SOFTWARE

MANUFACTURER: NOVELL   NETWORK: ADVANCED NETWARE/286

OPERATING SYSTEM INTERFACE
    o Full NETBIOS support/emulation
    o MS-DOS Lock/Unlock (INT 21, 5C)
    o DOS 2.0+, DOS 3.0+ workstation operating system

GENERAL FUNCTIONALITY
    o LAN hardware supported by software:

AST PCNetII	AT&T StarLAN
Corvus Omninet	Gateway G-net
IBM PC Cluster	Micom Inter-LAN Ethernet
Networth LAN	Novell NetWare Etherlink Plus
Orchid PCnet	Novell NetWare G-Net
Sperry USERNET	Texas Instruments Etherlink
3Com Etherlink	3Com Etherlink Plus
Ungermann Bass Net/One	Univation Uninet
Davong Multilink	IBM Token Ring Network
Nastar PLAN 2000	Novell NetWare RX-Net
Novell NetWare	Proteon ProNet
Quadram Quadnet IX	Standard Microsystems ARCNET
Tiara Systems TiaraLink	Novell S-Net
Televideo Personal Mini	IBM PC Network
Sytek System 6000	Allen-Bradley LAN/PC
North Star Dimension	Molecular System 16/300

    o Software requirements when adding new nodes:
        A shell must be run at each station to establish a link with
        NetWare
    o 16 dedicated file servers supported
    o Inter-LAN operability supported:
        Inter-LAN communication is allowed through the X.25 protocol and
        other LAN to LAN options

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MANUFACTURER: NOVELL   NETWORK: ADVANCED NETWARE/286

GENERAL FUNCTIONALITY (continued)
    o Additional hardware devices supported by software:
            All third party hardware manufacturers are responsible for
            functionality within the NetWare environment
            Dial-in capability
            Shared modems
    o Security provided by software:
            User and directory rights include open, delete, write, create,
            read, search, modification of file flags, and parental rights
            File attributes are shareable, non-shareable, read only, and
            write
    o Other software features:
            Electronic mail standard
            External and internal bridging to like and unlike topologies and
            remote sources
            Mainframe gateways
            UPS monitoring
            Database transactional tracking with rollback and rollforward
            capabilities
            System administration from any network station
            Fault tolerance by tracking disk errors and system crashes

LIST PRICE: $2,195   GSA COST: $1,932

APPENDIX G

DBMS EVALUATION RESULTS AND VOLUME ESTIMATES

DBMS EVALUATION RESULTS AND VOLUME ESTIMATES

The evaluation results for DBMS software are detailed in this appendix. Included are the procedure for the benchmark tests, the benchmark test results, evaluation results for TUNS DBMS development, a required features checklist, estimated shared hard disk space requirements, evaluation procedures, and evaluation summary.

The purpose of the benchmarking is to compare the performance of various database packages. All timings should be measured from the time of the last required keystroke by the user until the first display of information on the screen, unless otherwise specified.

INITIALIZATION

The database should be loaded with 10,000 records in random order. Each record should have the following format:

Bytes	Field name	Contents	
1-10	UKEY-A	TESTS nnnn	(alphanumeric field)
11-14	UKEY-N	nnnn	(numeric field)
15-24	DATA-A	DESCS nnnn	(alphanumeric field)
25-28	DATA-N	nnnn	(numeric field)
29-30	DKEY-A	mm	(alphanumeric field)
31-32	DKEY-N	mm	(numeric field)

In the record format above, nnnn represents a number from 0000 to 9999; mm represents the first two digits of the four-digit number (i.e., mm is from 00 to 99).

Bytes 1-10 should be defined as a unique alphanumeric key field. Bytes 11-14 should be defined as a unique numeric key field. Bytes 29-30 should be defined as a non-unique alphanumeric key field. Bytes 31-32 should be defined as a non-unique numeric key field.

BENCHMARK STEPS

1. Retrieving simple specific records

   Time how long it takes to retrieve each of the following records:

   UKEY-A="TESTS 1000"
   UKEY-A="TESTS 9000"
   UKEY-N=1000
   UKEY-N=9000
   DATA-A="DESCS 1000"
   DATA-A="DESCS 9000"
   DATA-N=1000
   DATA-N=9000

2. Retrieving specific records using boolean logic

   Time how long it takes to retrieve each of the following records:

   DATA-A="DESCS 1000" and UKEY-A="TESTS 1000"
   DATA-A="DESCS 1000" and UKEY-N=1000
   DATA-N=1000 and UKEY-A="TESTS 1000"
   DATA-N=1000 and UKEY-N=1000
   DKEY-A="10" and UKEY-A="TESTS 1000"
   DKEY-N=10 and UKEY-N=1000
   DATA-A="DESCS 9000" and UKEY-A="TESTS 9000"
   DATA-A="DESCS 9000" and UKEY-N=9000
   DATA-N=9000 and UKEY-A="TESTS 9000"
   DATA-N=9000 and UKEY-N=9000
   DKEY-A="90" and UKEY-A="TESTS 9000"
   DKEY-N=90 and UKEY-N=9000

3. Retrieving simple groups of records

   Time how long it takes to retrieve each of the following groups of records. Two times should be recorded for each group: the time

until the first information is displayed, and the time until all of the information has been displayed.

UKEY-A >= "TESTS 1000" and UKEY-A < "TESTS 1100"

UKEY-N >= 1000 and UKEY-N < 1100

DATA-A >= "DESCS 1000" and DATA-A < "DESCS 1100"

DATA-N > 1000 and DATA-N < 1100

DKEY-A = "10" and DATA-A >= "DESCS 1000"
                     and DATA-A < "DESCS 1100"

DATA-A >= "DESCS 1000" and DATA-A < "DESCS 1100"
                     and DKEY-A = "10"

DKEY-N = 10 and DATA-N >= 1000 and DATA-N < 1100

DATA-N >= 1000 and DATA-N < 1100 and DKEY-N = 10

UKEY-A >= "TESTS 9000" and UKEY-A < "TESTS 9100"

UKEY-N >= 9000 and UKEY-N < 9100

DATA-A >= "DESCS 9000" and DATA-A < "DESCS 9100"

DATA-N > 9000 and DATA-N < 9100

DKEY-A = "90" and DATA-A >= "DESCS 9000"
                     and DATA-A < "DESCS 9100"

DATA-A >= "DESCS 9000" and DATA-A < "DESCS 9100"
                     and DKEY-A = "90"

DKEY-N = 90 and DATA-N >= 9000 and DATA-N < 9100

DATA-N >= 9000 and DATA-N < 9100 and DKEY-N = 90

4. Adding new records

Redefine the field size for UKEY-N and DKEY-A. Time how long it takes to add each of the following records:

UKEY-A	UKEY-N	DATA-A	DATA-N	DKEY-A	DKEY-N
TESTS 1000A	20001	DESCS 1000A	20001	10	20
TESTS 9000A	10001	DESCS 9000A	10001	90	10
TESTS 5000A	10002	DESCS 5000A	10002	50	10
TESTS 1001A	10003	DESCS 1001A	10003	10	10

DBMS BENCHMARK RESULTS

FUNCTION	DBASE III+ TIME (in sec.)	DBASE III+ WITH CLIPPER TIME (in sec.)	KMAN/2 TIME (in sec.)	PC/FOCUS TIME (in sec.)	R:BASE SYSTEM V TIME (in sec.)	UNIFY TIME (in sec.)
Retrieve each of the following records						
UKEY-A="TESTS 1000"	1	1	1	<1	1	1
UKEY-A="TESTS 9000"	1	1	1	<1	1	1
UKEY-N=1000	1	1	1	<1	1	1
UKEY-N=9000	1	1	1	<1	1	1
DATA-A="DESCS 1000"	41	10	54	12	21	40
DATA-A="DESCS 9000"	355	10	494	12	21	40
DATA-N=1000	41	10	53	12	18	40
DATA-N=9000	370	10	484	12	18	40
Retrieve records using boolean logic						
DATA-A="DESCS 1000" and UKEY-A="TESTS 1000"	1	1	1	<1	1	1
DATA-A="DESCS 1000" and UKEY-N=1000	1	1	1	<1	1	1
DATA-N=1000 and UKEY-A="TESTS 1000"	1	1	1	<1	1	1
DATA-N=1000 and UKEY-N=1000	1	1	1	<1	1	1
DKEY-A="10" and UKEY-N=1000	1	1	1	<1	1	1
DKEY-N=10 and UKEY-N=1000	1	1	1	<1	1	1
DATA-A="DESCS 9000" and UKEY-A="TESTS 9000"	1	1	1	<1	1	1
DATA-A="DESCS 9000" and UKEY-N=9000	1	1	1	<1	1	1
DATA-N=9000 and UKEY-A="TESTS 9000"	1	1	1	<1	1	1
DATA-N=9000 and UKEY-N=9000	1	1	1	<1	1	1
DKEY-A="90" and UKEY-A="TESTS 9000"	1	1	1	<1	1	1
DKEY-N=90 and UKEY-N=9000	1	1	1	<1	1	1
Retrieve simple groups of records						
UKEY-A>="TESTS 1000" and UKEY-A<="TESTS 1100"	21	10	35	13	30	11
UKEY-N>=1000 and UKEY-N<1100	22	10	33	12	26	41
DATA-A>="DESCS 1000" and DATA-A<"DESCS 1100"	60	49	88	12	30	41
DATA-N>1000 and DATA-N<1100	62	48	87	12	25	41
DKEY-A="10" and DATA-A>="DESCS 1000" and DATA-A<"DESCS 1100"	20	6	32	5	34	9
DATA-A>="DESCS 1000" and DATA-A<"DESCS 1100" and DKEY-A="10"	60	64	88	13	10	9
DKEY-N=10 and DATA-N>=1000 and DATA-N<1100	20	6	33	5	27	9
DATA-N>=1000 and DATA-N<1100 and DKEY-N=10	62	64	87	13	10	11
UKEY-A>="TESTS 9000" and UKEY-A<="TESTS 9100"	22	10	35	12	31	41
UKEY-N>=9000 and UKEY-N<9100	22	10	34	12	25	41
DATA-A>="DESCS 9000" and DATA-A<"DESCS 9100"	373	49	528	12	30	41
DATA-N>9000 and DATA-N<9100	361	48	521	12	25	8
DKEY-A="90" and DATA-A>="DESCS 9000" and DATA-A<"DESCS 9100"	20	6	33	5	35	8
DATA-A<="DESCS 9000" and DATA-A<"DESCS 9100" and DKEY-A="90"	373	64	530	13	10	8
DKEY-N=90 and DATA-N>=9000 and DATA-N<9100	20	6	33	5	28	8
DATA-N>=9000 and DATA-N<9100 and DKEY-N=90	361	64	518	13	10	8

Add the following records

UKEY-A	UKEY-N	DATA-A	DATA-N	DKEY-A	DKEY-N	DBASE III+	CLIPPER	KMAN/2	PC/FOCUS	R:BASE	UNIFY
TESTS 1000A	20001	DESCS 1000A	20001	10	20	1	3	1	20	1	2
TESTS 9000A	10001	DESCS 9000A	10001	90	10	1	3	1	21	1	2
TESTS 5000A	10002	DESCS 5000A	10002	50	10	1	3	1	1	1	1
TESTS 1001A	10003	DESCS 1001A	10003	10	10	1	3	1	1	1	1

	DBASE III+	CLIPPER	KMAN/2	PC/FOCUS	R:BASE	UNIFY
TOTAL	2706	594	3820	324	484	509
SCALED FROM 1 TO 20	6	18	1	20	19	19

DBMS TUNS DEVELOPMENT EVALUATION RESULTS Function	Possible Rating	DBASEIII+ Rating	KMAN/2 Rating	PC/FOCUS Rating	R:BASE SYSTEM V Rating	UNIFY Rating
High-level interface	40					
Language	10		6	3	6	10
Can use vendor-provided utilities	5		2	0	2	5
Access to all DML functions	5		3	1	3	5
Ease of handling record contention	5		3	5	4	3
Parsing not required	2		2	0	2	2
High-level exists	13		13	13	13	13
OR						
Vendor-provided language						
IF-THEN, DO-WHILE, CASE	4	4				
Subroutines	4	3				
No need to specify index	2	1				
Read/write non-DBMS files	4	0				
Access DOS commands	4	4				
Execute non-DBMS programs	4	4				
Ease of handling record contention	4	2				
Compiler available	4	4				
Screen/forms	20					
Full-screen screen generator	2	2	2	1	2	2
Joins on forms	2	2	1	2	2	1
Automatic lookups in other files	2	0	0	2	2	2
Automatic display of lookup data	2	0	0	2	2	2
Data format validation	2	2	0	1	2	2
Access forms from high-level lang	2	0	1	1	2	1
Control over mode (add, chg, del)	3	1	1	1	1	2
Automatic query-by-form	2	0	1	0	1	3
Menu driver	3	0	1	0	2	3
Speed/performance	20	6	1	20	19	19
Report generation	8					
Free-form placement of text and data	2	2	2	2	2	2
Totals, averages	2	2	1	2	2	2
Multiple joins	2	2	1	2	2	2
Nested conditions	2	1	1	2	1	2
Reference documentation	5	5	3	1	4	4
Available on mini/mainframe	5	0	0	4	0	4
Other vendor-provided utilities	2	1	2	2	2	1
TOTAL	100	48	47	67	77	92

DBMS REQUIRED FEATURES Feature	DBASEIII+	KMAN/2	PC/FOCUS	R:BASE SYSTEM V	UNIFY
Menu driven	Yes	Yes	No	Yes	Yes
Command driven	Yes	Yes	Yes	Yes	Yes
Help screens	Yes	Yes	No	Yes	Yes
Multi-user or networking	Yes	Yes	Yes	Yes	Yes
Record locking	Yes	Yes	Yes	Yes	Yes
Applications development generator	Yes	Yes	Yes	Yes	Yes
Report generator	Yes	Yes	Yes	Yes	Yes
Report control breaks, totals, averages	Yes	Yes	Yes	Yes	Yes
Ad hoc query	Yes	Yes	Yes	Yes	Yes
Screen generator	Yes	Yes	No	Yes	Yes
Full screen utilization	No	No	No	No	Yes
Default screen formats	Yes	Yes	No	Yes	Yes
Data dictionary	No	Yes	No	Yes	Yes
Relational file structures or	Yes	Yes	Yes	Yes	Yes
network/hierarchical file structures	rel	rel	hier/rel	rel	rel/hier
Data types:					
Integer	Yes	Yes	Yes	Yes	Yes
String	Yes	Yes	Yes	Yes	Yes
Dollar	No	No	Yes	No	Yes
Logical	Yes	Yes	No	Yes	No
Memo	Yes	No	No	Yes	No
Date	Yes	No	Yes	Yes	Yes
Time	Yes	No	No	Yes	Yes
Range	Yes	No	Yes	Yes	No
Right/left justification	No	No	Yes	No	Yes
Default values	No	Yes	No	Yes	Yes
Field recognition editing	Yes	No	Yes	Yes	No
Data manipulation laguage interface	Yes	Yes	Yes	Yes	Yes
Multiple file interface	Yes	Yes	Yes	Yes	Yes
TOTAL YES RESPONSES (of 27)	22	19	17	24	23
PRORATED (40 MAXIMUM)	33	28	25	36	34

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SHARED HARD DISK SPACE REQUIREMENTS

Estimated Disk Reqmts. Over Life of Data.
Prorated Estimated Disk Reqmts.

FRD Control Number	Form/Report Title	Bytes	New Records per Year	Years Expected Life	30 Users	12 Users	5 Users
UASST-TM-1	TU Team Members Directory	314	500	1	157,000	62,800	26,167
UASST-ER-1	Expert Referral Profile Directory	166	500	1	83,000	33,200	13,833
UASST-ER-2	Expert Referral Site Directory	669	500	1	334,500	133,800	55,750
UASST-ONL-1	Online Database Directory	1,510	300	1	453,000	181,200	75,500
UASST-TUPROJ-1	TU Projects (Applications/CCDS)	1,210	200	1	242,000	96,800	40,333
UASST-MTM-1	Marketing/Training Materials Directory	747	1,000	1	747,000	298,800	124,500
UASST-TPI-1	Technical Problem Inquiry Database	1,298	300	4	1,557,600	623,040	259,600
UASST-PIA-1	Problem Inquiry Abstract	1,372	300	4	1,646,400	658,560	274,400
UASST-PIL-1	Problem Inquiry Response Letter	2,530	300	4	3,036,000	1,214,400	506,000
UASST-TAOTHR-1	Other Technical Abstract Database	1,368	150	4	820,800	328,320	136,800
UASST-SPACE-1	Space Benefits Information	2,924	500	4	5,848,000	2,339,200	974,667
NTR-FD-1	NASA New Technology Report	6,099	300	7	12,807,900	5,123,160	2,134,650
NTR-NTE-2	New Technology Evaluation Report	4,484	300	7	9,416,400	3,766,560	1,569,400
NTR-PTB-1	Prepublication Technical Brief	4,152	200	3	2,491,200	996,480	415,200
NTR-AW-1	Approved NASA Space Act Tech Brief Award	319	20	3	19,140	7,656	3,190
NTR-AW-2	Space Act Patent Awards Application	331	20	3	19,860	7,944	3,310
NTR-CA-1	Contract/Grant Information	736	200	7	1,030,400	412,160	171,733
NTR-CA-2	Potential Reportable Items	243	500	7	850,500	340,200	141,750
NTR-CA-4	Contractor/Grantee Information	260	200	12	624,000	249,600	104,000
NTR-CA-5	Correspondence Tracking	378	2,000	7	5,292,000	2,116,800	882,000
NTR-CA-6	Contract/Grant Reminders	633	200	7	886,200	354,480	147,700
NTR-IHA-1	In-House Potential NT Item List	957	200	7	1,339,800	535,920	223,300
NTR-IHA-2	Potential NT Item - In-House Correspondence	236	400	7	660,800	264,320	110,133
NTR-TR-5	NTR Tracking History	837	500	7	2,929,500	1,171,800	488,250
NTR-SDI-1	NTR Innovator Report	391	900	12	4,222,800	1,689,120	703,800
Total for Databases					57,515,800	23,006,320	9,585,967
25% for Index					14,378,950	5,751,580	2,396,492
Total * 2					143,789,500	57,515,800	23,964,917

EVALUATION OF SUITABILITY FOR APPLICATIONS DEVELOPMENT

In this evaluation, DBMS software products were rated on seven factors:

o   language interface   40 points;
o   screens/forms   20 points;
o   speed   20 points;
o   reports   8 points;
o   reference documentation   5 points;
o   mini/mainframe availability   5 points; and
o   vendor-provided utilities   2 points.

For rating purposes, factors were weighted based on the impact of the specific factor on the ability of the DBMS to support development of the TUNS-specific applications. Maximum possible points, as indicated above, were assigned to each factor. Points were awarded to specific software packages based on a combination of quantitative and qualitative information.

Points for the language interface, for the screens/forms support provided by the package, and for report generation were awarded according to the checklist on page G-6 of this appendix. Within each listed item, points were assigned based on a comparison of the capabilities of each package.

Points for speed were awarded based entirely on the results of the benchmark test. The total time was calculated for each package. The totals were then scaled from one to twenty. The slowest software was awarded one point for speed; the fastest package received the maximum possible points.

Points for reference documentation were awarded by the evaluation team based on the team's judgment of the completeness of the reference documentation, and the ease with which specific information was found. Software packages were ranked on their availability on either minicomputers or mainframe computers. They were also rated on the extent to which vendors provided additional utilities, such as menu drivers and communications packages. Points were awarded accordingly.

EVALUATION OF SUITABILITY FOR END-USER APPLICATIONS

DBMS software products were rated on six factors for end-user applications:

o	required features	40 points;
o	ease of use	25 points;
o	documentation	20 points;
o	ease of learning	10 points;
o	availability at TU sites	3 points; and
o	cost	2 points.

For rating purposes, factors were weighted based on the impact of the specific factor on the ability of the DBMS to meet TUNS requirements. Maximum possible points, as indicated above, were assigned to each factor. Points were awarded to specific software packages based on a combination of quantitative and qualitative information.

Points for required features were pro-rated according to the number of requisite capabilities demonstrated by each package.

Points for ease of use were determined by a consensus of the evaluation team based on their experience with the software during the evaluation process.

Points for documentation were awarded by the evaluation team based on the team's judgment of the organization of the manual, and the understandability and completeness of the examples.

The evaluation team judged each product based on their experience in learning the package for the first time. These were qualitative decisions based on the team members' experience with a wide variety of software packages.

Software packages were ranked by their availability at TU sites and by cost. Points were awarded accordingly.

A summary of all the evaluation results follows.

FACTOR	POINTS POSSIBLE	DBASE III+	KMAN/2	PC/FOCUS	R:BASE SYSTEM V	UNIFY
Language	40	22	29	22	30	38
Screens/forms	20	7	7	10	15	18
Speed	20	6	0	20	19	19
Reports	8	7	5	8	7	8
Documentation	5	5	3	1	4	4
Availability (mini/mainframe)	5	0	0	4	0	4
Utilities	2	1	2	2	2	1
TOTAL	100	48	46	67	77	92

DBMS SUITABLITY FOR APPLICATIONS DEVELOPMENT

FACTOR	POINTS POSSIBLE	DBASE III+	KMAN/2	PC/FOCUS	R:BASE SYSTEM V	UNIFY
Required Features	40	33	28	25	36	34
Ease of Use	25	19	15	17	23	20
Documentation	20	15	10	8	15	13
Ease of Learning	10	9	8	4	9	6
Site Availability	3	2	1	0	1	0
Cost	2	1	1	1	2	1
TOTAL	100	79	63	55	86	74

DBMS SUITABILITY FOR END-USER APPLICATIONS

EVALUATION	POINTS POSSIBLE	DBASE III+	KMAN/2	PC/FOCUS	R:BASE SYSTEM V	UNIFY
Development	100	48	46	67	77	92
End-User	100	79	63	55	86	74
TOTAL	200	127	109	122	163	166

DBMS EVALUATION SUMMARY

APPENDIX H

SPREADSHEET EVALUATION RESULTS

The evaluation results for spreadsheet software are detailed in this appendix. Included are the procedure for the benchmark tests, the benchmark test results, a required features checklist, evaluation procedures, and evaluation summary.

PROCEDURE FOR BENCHMARKING SPREADSHEETS

The purpose of the benchmarking is to compare the performance of various spreadsheet packages. All timings should be measured from the time of the last required keystroke by the user until the first display of information on the screen.

INITIALIZATION

The spreadsheet should be created with a matrix of 26 (columns) by 50 (rows) cells. All cells have the same format and the initial value of 0.00, except for A1 which has the value of 1.00. Save the spreadsheet on the hard disk.

BENCHMARK STEPS

1. Load the spreadsheet

    Time how long it takes to load the spreadsheet onto the screen

2. Addition

    o B1=A1+.01
    o A2=A1+.01

3. Copy formulas - recalculate all cells

    o Copy formula for row: Copy B1 to C1 through Z1
    o Copy formula for column: Copy A2 to A3 through A50
    o Copy formula for multiple columns: Copy A2 to B2 through Z50.

4. Recalculate the spreadsheet - multiplication and exponentiation

Time how long it takes to recalculate the spreadsheet using the formulas below:

   o B1=A1*1.01
   o A2=A1*1.01
   o B1=A1**1.01
   o A2=A1**1.01

5. Copy formula - recalculate all cells

   o Copy A2 to B2 through Z50

6. Total columns and rows

   o A51=A1+A2+A3+ . . . A50
   o B51=B1+B2+B3+ . . . B50
   o C51=C1+C2+C3+ . . . C50
   o AA1=A1+B1+C1+ . . . Z1
   o AA2=A2+B2+C2+ . . . Z2
   o AA3=A3+B3+C3+ . . . Z3

7. Recalculate the total of columns and rows by changing a number

   o A2=2
   o B1=2
   o B2=1

8. Insert columns and rows - cursor at A1

   o Insert column A
   o Insert columns H through K
   o Insert row 20
   o Insert rows 25 through 30

9. Delete columns and rows - cursor at A1

      o Delete column A

      o Delete columns H through K

      o Delete row 20

      o Delete rows 25 through 30

SPREADSHEET BENCHMARK RESULTS

Function	1-2-3 Key Stroke	1-2-3 Time (in sec.)	SuperCalc4 Key Stroke	SuperCalc4 Time (in sec.)	Twin Key Stroke	Twin Time (in sec.)
Load the spreadsheet						
o Load the spreadsheet onto the screen	4	2	4	4	4	4
Addition						
o B1=A1+.01	8	1	7	1	8	1
o A2=A1+.01	8	1	7	1	8	1
Copy formulas						
o Copy B1 to C1...Z1	9	1	9	1	9	1
o Copy A2 to A3...A50	10	1	10	1	10	1
o Copy A2 to B2...Z50	10	3	10	8	10	5
Multiplication - recalculate the spreadsheet						
o B1=A1*1.01	8	2	7	2	8	3
o A2=A1*1.01	8	2	7	2	8	3
Exponentiation - recalculate the spreadsheet						
o B1=A1^1.01	8	2	7	2	8	3
o A2=A1^1.01	8	2	7	2	8	3
Copy formula - recalculate the spreadsheet						
o Copy A2 to B2...Z50	10	12	10	19	10	51
Sum of columns and rows						
o A51=A1+A2+A3+...A50	13	2	12	17	13	26
o B51=B1+B1+B3+...B50	7	2	7	17	7	26
o C51=C1+C2+C3+...C50	7	2	7	17	7	26
o AA1=A1+B1+C1+...Z1	12	2	10	17	12	26
o AA2=A2+B2+C2+...Z2	7	2	7	17	7	26
o AA3=A3+B3+C3+...Z3	7	2	7	17	7	26
Change the content of the cell - recalculate the spreadsheet						
o A2=2	2	2	2	18	2	25
o B1=2	2	2	2	18	2	25
o B2=1	2	2	2	18	2	25
Insert columns and rows - cursor at home						
o Insert column A	5	2	4	19	5	25
o Insert columns H...K	10	2	7	19	10	26
o Insert row 20	8	2	6	19	8	27
o Insert rows 25...30	12	2	9	19	12	27
Delete columns and rows - cursor at home						
o Delete column A	5	2	4	19	5	26
o Delete columns H...K	10	2	7	19	10	26
o Delete row 20	8	2	6	19	8	27
o Delete rows 25...30	12	2	9	19	12	27
TOTAL	220	63	193	351	220	518
TOTAL TIME SCALED FROM 1 TO 20		20		7		1
TOTAL KEYSTROKES SCALED FROM 1 TO 5	1		5		1	

SPREADSHEET REQUIRED FEATURES Feature	1-2-3	SuperCalc4	Twin
Menu driven	Yes	Yes	Yes
Help screen	Yes	Yes	Yes
Applications development generator	No	No	No
MACROs	Yes	Yes	Yes
File compatability:			
ASCII	Yes	Yes	Yes
DIF	Yes	Yes	Yes
WKS	Yes	Yes	Yes
Word processing interface (ASCII export)	Yes	Yes	Yes
Data base	Yes	Yes	Yes
Graphics	Yes	Yes	Yes
Boolean operators	Yes	Yes	Yes
Date	Yes	Yes	Yes
Financial	Yes	Yes	Yes
Statistical	Yes	Yes	Yes
Manual/automatic recalculations	Yes	Yes	Yes
Print MACROs	Yes	Yes	Yes
Print ranges, formulas	Yes	Yes	Yes
Headers, footers	Yes	Yes	Yes
Cut and paste	Yes	Yes	Yes
TOTAL YES RESPONSES (of 19)	18	18	18
PRORATED (40 MAXIMUM)	38	38	38

Spreadsheet software products were rated on seven factors:

- o   required features   40 points;
- o   speed   20 points;
- o   ease of use   15 points;
- o   documentation   10 points;
- o   ease of learning   10 points;
- o   availability at TU sites 3 points; and
- o   cost   2 points.

For rating purposes, factors were weighted based on the impact of the specific factor on the ability of the spreadsheet to meet TUNS requirements. Maximum possible points, as indicated above, were assigned to each factor. Points were awarded to specific software packages based on a combination of quantitative and qualitative information.

Points for required features were pro-rated according to the number of requisite capabilities demonstrated by each package.

Points for speed were awarded based entirely on the results of the benchmark test. The totals were then scaled from one to twenty. The slowest software was awarded one point for speed; the fastest package received the maximum possible points.

Five points of the ease of use rating were based on the number of keystrokes required to perform the benchmark tests. The total keystrokes were calculated for each package. The totals were then scaled from one to five. The software requiring the most keystrokes received one point; the package requiring the fewest keystrokes was awarded the maximum points. The remaining points for ease of use were determined by a consensus of the evaluation team based on their experience with the software during the evaluation process.

Points for documentation were awarded by the evaluation team based on the team's judgment of the organization of the manual, and the understandability and completeness of the examples.

The evaluation team judged each product based on their experience in learning the package for the first time. These were qualitative decisions based on the team members' experience with a wide variety of software packages.

Software packages were ranked by their availability at TU sites and by cost. Points were awarded accordingly.

A summary of these results follows.

FACTOR	POINTS POSSIBLE	1-2-3	TWIN	SUPERCALC 4
Required features	40	38	38	38
Speed	20	20	0	7
Ease of use	15	7	8	15
Documentation	10	9	6	9
Ease of learning	10	8	8	10
Site availability	3	3	0	1
Cost	2	1	2	1
TOTAL	100	86	62	81

SPREADSHEET EVALUATION SUMMARY

APPENDIX I

WORD PROCESSING EVALUATION RESULTS

WORD PROCESSING EVALUATION RESULTS

The evaluation results for word processing software are detailed in this appendix. Included are the procedure for the benchmark tests, the benchmark test results, a required features checklist, evaluation procedures, and evaluation summary.

C-3.

PROCEDURE FOR BENCHMARKING WORD PROCESSORS

The purpose of the benchmarking is to compare the performance of various word processing packages.

INITIALIZATION

Load the 5-page test file into the word processing package. The test file contains only printable ASCII characters and a hexadecimal "0A" (linefeed). Format the test file with 55 lines per page, and margins set at 10 and 70. Save the file as a word processing document.

BENCHMARK STEPS

1. Load the file

    Time how long it takes to load a file with 5 pages of text

2. Save the file

    Time how long it takes to save a file with 5 pages of text

3. Search and replace strings

    3.1 Search for the following strings with the cursor positioned at the beginning of the file:

    o   String of "R:Base 5000 also provides an application"
    o   String of "an x-y graph, or"
    o   String of "This feature was a long time coming"

3.2 Search and replace the following strings with the cursor at the beginning of the file:

o   Replace "R:base 5000 also provides an application" with "R:BASE 5000 ALSO PROVIDES AN APPLICATION"
o   Replace "an x-y graph, or "with "AN X-Y GRAPH, OR"
o   Replace "This feature was a long time coming" with "THIS FEATURE WAS A LONG TIME COMING"

3.3 Search and replace the following strings with the cursor at the beginning of the file. This replacement causes the text file to reformat:

o   Replace "SSI" with "Satellite Software International"
o   Replace "Samna" with Samna Work III"

4.   Repaginate the text file following a margin change

o   Change the 61-character line length to 51-character
o   Reset the 51-character line length back to 61-character

5.   Copy a block of text

   o   Copy first paragraph (7 lines) to the end of file
   o   Copy second paragraph (17 lines) to the end of file
   o   Copy first page of text to the end of file

6.   Delete a block of text

   o   Delete last 7 lines of the file
   o   Delete last 17 lines of the file
   o   Delete last page of the file

7.   Move a block of text

   o   Move the first paragraph (7 lines) to the end of file
   o   Move the second paragraph (17 lines) to the end of the file
   o   Move the first page of the file to the end of the file

8.   Scroll by line from top to bottom of the file

   o   With the cursor positioned on screen at the beginning of the
       file, hold down the down arrow key and record the time required
       for the cursor to reach the last line of the file

9.   Print a file

   o   Time how long it takes to print a file with 5 pages of text

WORD PROCESSOR BENCHMARK RESULTS — Function	SAMNA KS	SAMNA Time	WORDPERFECT KS	WORDPERFECT Time	WORDSTAR KS	WORDSTAR Time	LEADING EDGE KS	LEADING EDGE Time	WORD KS	WORD Time
Load a file — o Load a file with 5 pages of text	2	4	3	2	2	4	1	3	4	
Save a file — o Save a file with 5 pages of text	2	3	3	6	3	9	2	1	4	
Search the following strings — o R:base 5000 also provides an applications	5	21	2	2	4	4	2	7	3	
o an x-y graph, or	5	48	2	3	4	3	2	13	3	
o This feature was along time coming	5	127	2	5	4	5	2	25	3	
Search and replace the following strings: — o Replace all 'R:base 5000 also provides an applications' with 'R:BASE 5000 ALSO PROVIDES AN APPLICATIONS'	11	135	4	7	7	6	5	35	4	1
o Replace all "an x-y graph, or" with "AN X-Y GRAPH, OR"	11	157	4	8	7	6	5	33	4	
o Replace all "This feature was along time coming." with "THIS FEATURE WAS ALONG TIME COMING."	11	177	4	5	7	6	5	30	5	
Search and replace all occurrences with text reformat — o Replace "Samna" with "Samna Word III"	11	241	4	7	10	44	15	53	4	
o Replace "Lotus 1-2-3" with "1-2-3"	11	171	4	8	10	44	7	27	4	
o Replace "SSI" with "Satellite Software International"	11	175	4	6	10	44	7	35	4	
Repaginate with the margin changes * — o Change 61-character line length to 51-character line	55	540	4	2	29	79	52	3	7	
o Reset 51-character line length back to 61-character	65	618	4	2	29	72	62	3	7	
Copy the following — o Copy first paragraph (7 lines) to the end of file	14	6	7	7	6	9	13	5	4	
o Copy second paragraph (17 lines) to the end of file	24	14	7	9	6	10	15	7	4	
o Copy first page to the end of the file	8	88	7	11	8	11	10	9	4	
Delete the following — o Delete last page	3	37	3	3	7	2	2	6	4	
o Delete last 17 lines of the file	19	7	3	2	5	2	2	10	4	
o Delete last 7 lines of the file	9	3	3	2	5	2	2	9	2	
Move the following — o Move first paragraph (7 lines) to the end of file	14	8	7	7	6	9	12	3	7	
o Move second paragraph (17 lines) to the end of file	24	16	7	8	6	11	19	5	7	
o Move first page to the end of file	8	66	7	13	8	13	9	6	7	
Scroll by line from top to bottom of file — o With the cursor positioned on screen at home, press down arrow key and hold; record time required for cursor to reach last line of file	1	114	1	53	1	37	1	8	1	
Print file: — o Print a file with 5 pages	7	175	3	299	2	194	3	484	3	
TOTAL	336	2931	99	477	186	626	274	805	105	
TOTAL TIME SCALED FROM 1 TO 5		1		1		5		4		
TOTAL KEYSTROKES SCALED FROM 1 TO 15	1		15		9		4		15	

* WordStar does not do automatic reformat after the margin changed - can only reformat paragraph by paragraph

WORD PROCESSOR REQUIRED FEATURES Feature	SAMNA	WORDPERFECT	WORDSTAR	LEADING EDGE	WORD
Menu driven	No	Yes	Yes	Yes	Yes
Help screen	Yes	Yes	Yes	Yes	Yes
Spelling checker	Yes	Yes	Yes	Yes	Yes
Math capability	Yes	Yes	No	No	No
Block moves	Yes	Yes	Yes	Yes	Yes
Automatic backup files	Yes	Yes	Yes	Yes	Yes
Mail merge	Yes	Yes	Yes	Yes	Yes
Edit more than one file on screen	Yes	Yes	No	Yes	Yes
Combine documents	Yes	Yes	Yes	Yes	Yes
"go to" command	Yes	Yes (page #)	Yes (string)	Yes (page #)	Yes
Headers/footers	Yes	Yes	Yes	Yes	Yes
Search and replace	Yes	Yes	Yes	Yes	Yes
Automatic reformat	Yes	Yes	No	Yes	Yes
Format by paragraph	Yes	Yes	Yes	No	Yes
Format by page	Yes	Yes	No	Yes	Yes
Format by document	Yes	Yes	No	Yes	Yes
Cut and paste text	Yes	Yes	Yes	Yes	Yes
Insert/overwrite	Yes	Yes	Yes	Yes	Yes
Cursor movement - character	Yes	Yes	Yes	Yes	Yes
Cursor movement - word	Yes	Yes	Yes	Yes	Yes
Cursor movement - screen	No	Yes	Yes	Yes	Yes
Cursor movement - begin of file	Yes	Yes	Yes	Yes	Yes
Cursor movement - end of file	Yes	Yes	Yes	Yes	Yes
Delete character	Yes	Yes	Yes	Yes	Yes
Delete word	Yes	Yes	Yes	Yes	Yes
Delete page	Yes	Yes	No	Yes	Yes
Delete sentence	No	Yes	No	Yes	Yes
Delete Block	Yes	Yes	Yes	Yes	Yes
Boilerplate	Yes	Yes	Yes	Yes	Yes
Underline	Yes	Yes	Yes	Yes	Yes
Super/supscript	Yes	Yes	Yes	Yes	Yes
Horizontal/vertical scrolling	Yes	Yes	Yes	Yes	Yes
Boldface	Yes	Yes	Yes	Yes	Yes
Multiple columns	Yes	Yes	Yes	Yes	Yes
Index/table of content	Yes	Yes	No	No	Yes
Paginate/repaginate	Yes	Yes	Yes	Yes	Yes
Left/right justified text	Yes	Yes	Yes	Yes	Yes
Decimal tabs	Yes	Yes	Yes	Yes	Yes
Variable margin	Yes	Yes	Yes	Yes	Yes
Automatic centering	Yes	Yes	No	Yes	Yes
Automatic indentation	Yes	Yes	No	Yes	Yes
Insert printer control code	Yes	Yes	Yes	Yes	Yes
Insert printer stop code	Yes	Yes	Yes	Yes	Yes
Printer interrupt	Yes	Yes	Yes	Yes	Yes
Pause for text entry	Yes	Yes	No	Yes	Yes
Scientific notation	Yes	Yes	No	Yes	Yes
Commands - user-defined keys	Yes	Yes	No	No	No
Commands - repeat last command	Yes	Yes	Yes	Yes	Yes
Commands - cancel command	Yes	Yes	Yes	No	Yes
Commands - undo last command	Yes	Yes	No	Yes	Yes
Commands - repeat command N times	No	Yes	Yes	Yes	Yes
Display document directory	Yes	Yes	Yes	No	No
Create document summary sheet	No	Yes	Yes	Yes	Yes
Access DOS without exit the package	No	Yes	No	No	No
Rename document	Yes	Yes	No	No	Yes
Move document	No	No	Yes	Yes	Yes
Copy document	Yes	Yes	Yes	Yes	Yes
TOTAL YES RESPONSES (of 57)	51	56	40	49	52
PRORATED (45 MAXIMUM)	40	44	32	39	41

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EVALUATION PROCEDURES

Word processing software products were rated on seven factors:

o   required features   45 points;
o   ease of use   20 points;
o   documentation   15 points;
o   ease of learning   10 points;
o   speed   5 points;
o   availability at TU sites   3 points; and
o   cost   2 points.

For rating purposes, factors were weighted based on the impact of the specific factor on the ability of the word processing software to meet TUNS requirements. Maximum possible points, as indicated above, were assigned to each factor. Points were awarded to specific software packages based on a combination of quantitative and qualitative information.

Points for required features were pro-rated according to the number of requisite capabilities demonstrated by each package.

Fifteen points of the ease of use rating were based on the number of keystrokes required to perform the benchmark tests. The total keystrokes were calculated for each package. The totals were then scaled from one to fifteen. The software requiring the most keystrokes received one point; the package requiring the fewest keystrokes was awarded the maximum points. The remaining points for ease of use were determined by a consensus of the evaluation team based on their experience with the software during the evaluation process.

Points for documentation were awarded by the evaluation team based on the team's judgment of the organization of the manual, and the understandability and completeness of the examples.

The evaluation team judged each product based on their experience in learning the package for the first time. These were qualitative decisions based on the team members' experience with a wide variety of software packages.

Points for speed were awarded based entirely on the results of the benchmark test. The totals were then scaled from one to five. The slowest software was awarded one point for speed; the fastest package received the maximum possible points.

Software packages were ranked by their availability at TU sites and by cost. Points were awarded accordingly.

A summary of the evaluation results follows.

FACTOR	POINTS POSSIBLE	SAMNA	WORD PERFECT	WORD STAR	LEADING EDGE	MICROSOFT WORD
Required features	45	39	44	32	39	42
Ease of use	20	0	18	12	7	19
Documentation	15	10	12	13	10	13
Ease of learning	10	5	8	9	8	7
Speed	5	1	5	4	4	5
Site availability	3	0	2	3	0	1
Cost	2	1	1	1	2	1
TOTAL	100	56	90	74	70	88

WORD PROCESSING EVALUATION SUMMARY

APPENDIX J

ELECTRONIC MAIL MEMORANDUM

ISN

M E M O R A N D U M

TO: Roy Bivins
       NASA TU Program Manager

FROM: Tom Judkins
       ISN TU Program Manager

DATE: January 20, 1987

SUBJECT: Comparison of Commercial E-Mail Costs and Features

    Enclosed is a report containing a comparison of available commercial Electronic Mail service features and costs. Twelve vendors were contacted during December and January. Of these, six were selected as representative and are included on the report. The Lawrence Livermore National Laboratory E-Mail is also included for comparison of features; no attempt was made to include costs for this provider.

    During the course of our investigation, discussions were held with the following NASA personnel to ascertain the policies governing the availability of the Telenet NASAMAIL system, the number of mailboxes allocated, the use of the system by contractor employees, and the E-Mail features:

        Mike Kleminski, Marshall Space Flight Center, (205) 544-0134
        Sandy Bates, NASA Headquarters, (202) 453-2007
        John Lattyak, NASA Headquarters, (202) 453-1768

    Additional information was provided by Mr. Dave Herring of US SPRINT, the owners of Telenet. Telenet, as you know provides both Telemail and NASAMAIL. The Telemail commercial rates for a minimum user are provided for comparison purposes. No attempt was made to determine the current rates NASA pays for NASAMAIL. The features of Telemail are shown and should be the same for NASAMAIL.

    Please contact me or Carl Lincoln if you have any questions, on (301) 469-0400

Information Systems & Networks Corporation • 10411 Motor City Drive, Bethesda, Maryland 20817 • (301) 469-0400 Telex: 387814

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COMMERCIAL ELECTRONIC MAIL

Comparison of Cost and Features
January 15, 1987

The attached two spreadsheets compare the costs and features of six commercial vendors of Electronic Mail (E-Mail). The quotes of cost and features were, in most cases, obtained over the phone with assurances that follow-up printed material would be forwarded in the near future.

Costs

The "Cost" spreadsheet provides the quoted user start-up fee, usage connect charge, and miscellaneous storage charges. All figures shown are for commercial users and are subject to various discounts on volume, GSA pricing schedules, and negotiations.

Explanation of Spreadsheet Columnar Headings:

Carrier: Commercial vendor and title of E-Mail service

Fee: Monthly or yearly charge for each account, multiple users may be billed to one account.

Connect Charge: Where indicated, rates are based upon line speed. The speed used here was 1200 bps.

Storage: Only McDonald Douglas' "Ontyme" imposes a storage charge for unread messages.

Discounts: Vendors expressed willingness to provide price breaks on volume. (see GSA schedules)

Access Points: Most vendors have a local access telephone number in 300 or more metropolitan areas. Where a local access number is not available, WATS lines may be used for about $19.00 per hour.

Contact: Salesperson's telephone number.

Cost/7200 Char: At 1200 bits per second, 10 bits per character, 7200 characters represents one minute of uninterrupted transmission. This number is then multiplied by the cost factors in the column headed Connect Charge. Monthly or yearly fees are not included.

The cost for Lawrence Livermore National Laboratory E-Mail is not included. GSA Schedule rates, which appear on schedules such as the Teleprocessing Services Multiple Award Schedule Contract, are also not included in this survey, since those schedules are available in NASA procurement offices.

Other vendors are in the E-Mail market, but either did not wish to respond to the initial inquiry or could not be contacted during the holidays. The GSA Teleprocessing Services Multiple Award Schedule Contract contains about forty E-Mail vendors for which rates and services have been established. These vendors are available and may have a contract awarded after benchmarking and further competitive requirements have been met. It should also be noted, however, that further reductions to these schedule rates may be offered by the vendor prior to award.

Features

The "Features" spreadsheet compares a group of common E-Mail features. Each vendor has their own list of special features which are nice but not essential to the basic purpose of E-Mail, and therefore are not included in the survey, such as the ability to do database retrieval, some programming, and Order Entry.

Various vendors target their services to a particular market segment, such as international mail service, or communications as opposed to domestic E-Mail. Graphnet is an example of the latter; Graphnet transmits the message to the addressee's mailbox, but once the message is read, it is deleted. It is the reader's responsibility to make a permanent copy while the message is being read because, as it is being read, it is also being purged from the Graphnet system. Graphnet does not store copies of delivered messages. Other vendors such as TRT Telecommunications Crop. service only the international E-Mail market.

The following list is a glossary of terms appearing on the "Features" spreadsheet:

BASIC SERVICE	For inexperienced users; full menus & commands.
ADVANCED SERVICE	For experienced users; abbreviated menus & commands.
ELECTRONIC ADDRESS	Electronic mail box.
HARD COPY ADDRESS	Hand delivered at receiving end.
TELEX TERMINAL	Five or ten baud terminal.
ONLINE HELP	Command tutorial.
HOT LINE MESSAGE	Message to system administrator or vendor.
CUSTOMER SUPPORT	Vendor support services.
USER DIRECTORIES	Names of other user mailboxes.
SPELLING CHECKER	Checks message text for spelling errors.
SEARCH-BY-DATE	Pick out messages of a given date.
SEARCH-BY-SUBJECT	Pick out messages by subject.
MESSAGE NUMBER	A sequential number assigned by the computer to every message.
READ ALL	Display all specific messages, identified by number.
READ BY NUMBER	Display a specific message, identified by number.
MESSAGE PURGE	Discard message.

MESSAGE FORWARDING	Send a received message to someone else.
USER LIST	A list of other E-Mail addresses.
MESSAGE FILING	Saving a message in a permanent place.
REPEAT-SEND-BY- COUNT	Sending a message more than once; automatically "counts" number of times, perhaps every hour, etc.
RETURN RECEIPT	Notice given sender when message is read by addressee.
REGISTERED	Addressee must acknowledge receipt before reading message.
URGENT	Message placed on top of addressee's queue.
SPEND PRIVATE	Addressee must enter password before permission to read is granted.
CANCEL SEND	Cancel if not delivered.
BLIND COPY	Send copy without so noting on carbon copy.
HIERARCHICAL USERCODE	Usercode permission follows organizational structure.
BINARY FILE	Binary codes which can not be represented by ASCII characters

E-Mail vendors sometimes offer two levels of user service, with separate rates for each. One level is for the novice who needs constant reminder of menu selections. This level is referred to as Basic on the spreadsheet. The user is presented with a menu before each change, there-by helping to make operation easier. The more experienced user becomes annoyed by frequent appearance of menus and would prefer an abbreviated form of controlling the communication session. This is the Advanced class of service.

Some vendors have provisions for addressing mail to courier services for hand delivery, this is sometimes referred to as paper mail. Access is also provided by some vendors to Telex I and Telex II, domestic and international customers. Messages can be delivered to these facilities by mailbox or to an auto-answer modem.

Help facilities are available both on line and by calling an (800) number for operator assistance. DIALCOM has the ability to communicate with an operator while on line by typing messages. All vendors have a Customer service telephone number, usually toll free, to provide operator assistance. Not all are available 24 hours a day, however. The spreadsheet indicates which are not available 24 hours by showing the number of hours (e.g. 12) an operator is available.

For those vendors providing the service, various means of sending, reading, and deleting messages are available. It is possible to post a message and have it sent after a specified time and date, and to have the message repeated a specified number of times; or append a message to one which has been received and forward both messages to another addressee. These services are available for the standard rates quoted, not as add-ons. Of course not all vendors offer the same services. DIALCOM and Telenet seem to offer the most of these additional services, of the six vendors contacted.

Many vendors offer a Bulletin Board service which can be exclusive to a group of users. This feature allows up and down loading of binary files, such as copies of PC programs. Most are using the XMODEM file transfer protocol which is common to most PC communications software packages.

Gateways are offered to other networks; however, some vendors permit access to information services only, such as Compuserve.

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E-MAIL COSTS

CARRIER	FEE	CONNECT CHARGE	STORAGE	DISCOUNTS	ACCESS PTS	COST/7200 CHARS	Message Hour
WESTERN UNION "EASYLINK"	$25/yr; 10/yr for each add'l user	AT 1200 bps: $0.50/min + $0.20/ address $0.30/min for WATS (800)	none for 5 days	10% if monthly billing over $1000	300+ cities	$0.80 + $0.20 for first addressee	$60.00
MCI "MCI MAIL"	$18/yr per user	$0.45/ 0 - 500 chars $1.00/ 501 - 7500 chars $1.00 / ea add'l 7500 chars	none for 10 days	none	300+ cities	$1.00	$60.00
McDonald Douglas "ONTYME"	$290/mo per account	$3.00/hr plus $0.25/k chars **	$0.01/1k chars/day	10% if monthly billing over $5000	300 + cities	$1.60	$110.00
US SPRINT "Telemail" +	$140/mo per account ($500.00 minimum)	$14/hr 7a.m.-9p.m.;$7 6-9p.m. $4/hr 9p.m.-6a.m. +$0.05/1000 $0.53/min for WATS (800) **	$0.007/BM per 1000 char	negotiable	300+ cities	$0.59	$35.40 **
DIALCOM "DIALCOM"	none $500.00 min	8:a-6sp $14/hr; else $6.50/hr $10 local +$0.05/1000	$0.20/2k after 2 mo	none	300+ cities	$0.76	$45.60 **
Graphnet, Inc	$15/mo per user	1200 bps: $0.80/min send only	none for 7 days	5% over $300 10% over $1000	300 + cities	$0.80	$48.00 **

* See NASAMAIL Telenet contract for rate schedule

NASAMAIL Administrator: Mike Kleminski; Huntsville, Ala. (205) 544-0134

Mr. Kleminski says the following:

1. Each NASA center projects their usage for the next fiscal year
2. Headquarters' estimate was for 1200 mailboxes
3. Most of those are assigned, but probably not in use
4. NASAMAIL may be used by contractors if sponsored by NASA
5. Mr Kleinski's NASAMAIL superior is Gail Posey, code M, HQ. (202) 453-2155

** For send and receive

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E-MAIL FEATURES	MCI MAIL	TELEMAIL	ONTYME	DIALCOM	EASYLINE	GRAPHNET	LINE
SERVICE CATEGORIES				X			
BASIC	X	X		X	X	X	X
ADVANCED	X	X	X				
ADDRESSES			X	X	X	X	X
ELECTRONIC ADDRESS	X	X			X	X	
HARDCOPY ADDRESS	X	X		X	X	X	
TELEX TERMINAL	X	X					
HELP CATEGORIES							X
ON LINE	X	X	X	X	X	X	
HOT LINE MESSAGE	X	X	X	X	12	X	6
CUSTOMER SUPPORT (24hrs)	12	X	X				
ON LINE INFORMATION				X	X	X	
INTERNATIONAL RATES	X	X		X		X	
LOCAL PHONE NUMBERS	X	X	X	X			
NUMBER OF MESSAGES SENT		X			X	X	X
USER DIRECTORIES	X	X				X	X
DATE/TIME		X	X	X			
SPELLING CHECKER		X					
MESSAGE RETRIEVAL		X		X			
SEARCH BY DATE	X	X		X			
SEARCH BY SUBJECT	X	X	X	X	X	X	X
READ BY NUMBER	X	X		X			
READ BY DATE	X	X	X	X			
READ ALL	X	X		X			
READ BY SUBJECT	X	X					
UNREAD							
MESSAGE PURGE	X	X	X	X	X		X
BY NUMBER				X			
FROM USERNAME		X		X			
BY DATE		X		X			
BY SUBJECT		X		X			
UNPURGE							
MESSAGE ANSWERING		X			X		X
ANSWER ALL	X	X	X	X	X	X	X
ANSWER MESSAGE NUMBER	X	X					
MESSAGE FORWARDING		X				X	X
TO USER LIST	X	X					
BY DATE							
FROM USERNAME	X	X	X	X		X	X
BY MESSAGE NUMBER	X	X		X			X
WITH APPENDED COMMENTS	X	X		X		X	
BY SUBJECT		X					
MESSAGE FILING		X	X	X		X	X
BY USERNAME		X		X			
BY MESSAGE NUMBER	X	X		X			
BY DATE		X		X			X
REMOVE ALL	X	X		X		X	
REMOVE BY MESSAGE NUMBER	X	X					

E-MAIL FEATURES	MCI MAIL	TELEMAIL	ONTYME	DIALCOM	EASYLINK	GRAPHNET	LLML
SEND MAIL							
BY DATE		X		X	X		
REPEAT SEND BY COUNT		X	X		X		
REPEAT SEND BY DATE/TIME		X	X		X		
RETURN RECEIPT REQUEST	X	X	X	X	X		X
SEND REGISTERED		X		X			
SEND URGENT	X	X		X		X	
SEND PRIVATE		X		X			
CANCEL SEND		X		X			
BLIND COPY				X	X		
BULLETIN BOARD	X	X	X	X	X		
USERCODE STURCTURE							
HIERARCHICAL		X	X				
LOW LEVEL QUALIFIER	X	X	X	X	X	X	X
PASSWORD MAINTENANCE	X	X	X	X	X		X
COMMAND DRIVEN	X	X	X	X	X	X	X
MENU DRIVEN	X	X		X			
BINARY FILE TRANSFER	X	X	X	X			
GATEWAY		X	X	X	X	X	X

APPENDIX K

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